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## EMANCIPATION FROM SCIENTIFIC MATERIALISM.<sup>1</sup>

IT has at all periods been a source of complaint that so little unanimity should prevail with regard to the most important and fundamental of human problems. In our own times, however, the grievance concerning one of the greatest of these questions has almost disappeared. For, although there still exist many and varied contradictions, nevertheless it may be asserted that scarcely in any age has there been so comparatively close an agreement regarding our conception of the outer world of phenomena as exists in this present scientific century of ours. From mathematician to practising doctor, every scientifically thinking man, if called upon to express his opinion as to the "inner structure" of the universe, would sum up his ideas in the conception that things consisted of atoms in motion, and that these atoms and their mutual forces were the final realities underlying all phenomena. We read and hear, with countless repetition, the statement that the only intelligent explanation of the physical world is to be found in a "Mechanics of the Atoms"; matter and motion appear as the final principles to which natural phenomena in all

<sup>1</sup> A paper read at the third general sitting of the Assembly of the Society of German Scientists and Physicians at Lübeck, 20th September, 1895. By Wilhelm Ostwald, Professor in Chemistry at the University of Leipzig. Authorised translation by F. G. Donnan and F. B. Kenrick.

their variety must be referred. This conception we may term scientific materialism.

I here propose to state my conviction that this so generally accepted view is untenable; that this mechanical idea of the universe does not fulfil the purpose for which it was designed, and that it is inconsistent with undoubted and generally known and recognised truths. The conclusion to be drawn from this is obvious. The scientifically untenable view must be abandoned and its place filled, if possible, by a new and a better one. The natural question as to whether such another and better conception can be found, I think I can answer in the affirmative. My remarks consequently divide themselves naturally into two parts: a destructive part and a constructive part. As in all cases, so here, destruction is easier than construction; the inefficiency of the customary mechanical treatment is more easy to demonstrate than the efficiency of the new one, which I would characterise as the "energetical" view. I may remark at once that the new view has already had an opportunity of proving its worth on quiet reflection, and by impartial research in particularly favourable regions of experimental science. Although this cannot prove its correctness, it still gives the new conception a claim to notice.

It will not perhaps be superfluous to state at the outset that I am dealing to-day exclusively with a question of natural science. I draw aside on principle from all conclusions of an ethical or religious nature which may be deduced from the result of this discussion. I do this not because I undervalue the significance of such conclusions, but because my arguments have been founded, independently of such considerations, on the firm ground of the exact sciences. For the tillage of this soil also, it may be said that he who putteth his hand to the plough and looketh back is not fit for this kingdom. The scientific investigator of nature is bound to set forth his results neither to pain nor to please, and we may trust ourselves to the power of Truth which, though perhaps temporarily, can never lead far from the right way him who seeks her earnestly.

I do not fail to recognise that my undertaking places me in opposition to the views of men who have done great things for science, and to whom we all look up in wonder and admiration. But do not charge me with presumption if I oppose myself to such men in a matter of so great importance. You do not call it presumption when the sailor on duty at the mast-head turns the great ship from her course by his cry of "Breakers ahead!" albeit he is but an insignificant member of her crew. His duty is to announce what he sees, and did he fail to do this he would prove untrue to this duty. It is in this sense a duty which I am to-day discharging. Nevertheless, no one is bound to alter his scientific course in answer to my cry of "Breakers ahead!" Every one is at liberty to test whether it is a reality that stands before my eyes, or whether a mirage deceives my vision. I believe however that the special nature of my scientific duties gives me for the moment a clearer insight into certain phenomena than may be had from other points of view, and for this reason I could not but regard it as wrong, were I for extraneous motives to leave unsaid what I have seen.

In order to find our way clearly through the infinite variety of the world of phenomena, we always make use of the same scientific method, namely, grouping together things that are similar and in variety seeking the non-varying. In this way our gradual mastery over the infinitely various phenomena of the outer world is acquired and ever more effective means of co-ordination are continually developed. From the simple *list* we proceed to the *system*, from this again to the *law of nature*, and the most comprehensive form of the latter condenses into a *general conception*. We perceive that the phenomena of the actual world, limitless as is their variety, form nevertheless only certain perfectly definite and particular cases of the theoretically conceivable possibilities. The significance of a Law of Nature consists in the determination of the *actual* among the *possible* cases, and the form to which each can be referred is the finding of an *invariant*, that is to say, a quantity which remains

unchanged even when all the other determining elements vary within the possible limits imposed by the law. Thus we perceive that the historical development of scientific conceptions is ever associated with the discovery and working out of such invariants; in them we behold the mile-stones which mark the track traversed by human knowledge.

Such an invariant of universal significance was found in the idea of mass. This gives not only the constants of the laws of Astronomy, but also appears no less invariable in the case of the most deep-going changes to which we can subject the objects of the outer world, namely, chemical changes. Accordingly this idea appeared to be excellently suited to form the central point of scientific law. Of course it was too poor in connotation to serve alone for the representation of the various phenomena, and had therefore to be correspondingly extended. This was effected by fusing with the simple mechanical idea the series of properties which are associated with the property of mass and are proportional to it. In this manner arose the conception of matter, in which everything was summed up that was associated in our sense-impressions with mass, and which always accompanied it, as, for example, weight, extension in space, chemical properties, etc., and the *physical law* of the conservation of mass passed into the *metaphysical axiom* of the conservation of matter.

It is important to observe that, with this extension, a great many hypothetical elements crept into a conception originally free from hypothesis. For example, in the light of this conception a chemical reaction had, contrary to appearance, to be so considered that none of the matter affected by the chemical change could possibly disappear and be replaced by new matter with new properties. On the contrary, the view required the assumption that when, for instance, all the perceptible properties of iron and oxygen had disappeared in iron oxide, nevertheless iron and oxygen still existed in the body produced and had only assumed other properties. At present we are so accustomed to such an idea that it is difficult for us to conceive its

strangeness, indeed its absurdity. But if we consider for a moment that all we know of a given substance consists in the knowledge of its properties it is evident that the assertion that a certain substance continues to exist without possessing these properties is not very far removed from pure nonsense. As a matter of fact, this purely formal assumption serves simply to unite the general facts of chemistry, in particular the stöchiometric laws of mass, with the arbitrary notion of an intrinsically unvarying matter.

But even the so extended idea of matter, together with the necessary attendant suppositions, is not sufficient to embrace all phenomena, not even indeed in the inorganic world. We think of matter as something in itself intrinsically motionless and unvarying; hence in order to make the representation of an ever-changing world possible, we must supplement this conception with another independent one which gives expression to this changeableness. A conception of this sort was, in the most successful manner, developed by Galileo, the founder of scientific physics, in the idea of force as the constant cause of motion. Galileo had, in fact, discovered an invariant of great importance for the varying phenomena of free and indirect fall; and with the assumption of the intrinsically constant force of gravitation, whose effects continuously accumulate, the complete representation of these phenomena became possible. The significance of this conception became evident when Newton, with his idea that the same force acted between the heavenly bodies, brought the whole star-world under the sway of science. It was this step forward in particular which gave rise to the conviction that just as the astronomical so also all other physical phenomena must be capable of representation by this means. When, moreover, at the beginning of our century the efforts of numerous, and especially French, astronomers had shown that Newton's law of gravitation could not only represent the motions of the heavenly bodies to a first approximation, but withstood also the far severer test of a second approximation in their ability to express with equal certainty and accuracy the

small deviations from the typical motions (*i.e.*, the perturbations), the confidence in the sufficiency of this theory must have been extraordinarily strengthened. What was then more likely than the expectation that the theory which had shown itself so perfectly adapted to represent the motions of the great bodies of the Universe, must be the correct, nay, the only means of bringing the events of the little world of atoms under the sway of science? So arose the mechanical conception of nature according to which all phenomena (at first of inorganic nature) were to be finally referred simply to the motions of atoms according to the same laws which had been recognised to hold for heavenly bodies. That this conception should be immediately carried over from the region of inorganic to that of animated nature, was a necessary consequence when it was once perceived that the same laws which hold in the former, claim here also their inviolable rights. This conception of the universe found its classical expression in Laplace's idea of the "Universe-Formula" by means of which every past and future event was to be capable of deduction by rigid analysis applied to mechanical laws. For this purpose an intellect was to be required which though far beyond the human mind in power was not essentially of a different nature.

We do not generally notice in what an extraordinary degree this widespread view is hypothetical, nay, metaphysical; on the contrary we usually regard it as the most exact expression for the actual relations. Nevertheless it must be remarked that a confirmation of the natural deduction from this theory, namely, that all non-mechanical phenomena such as heat, radiation, electricity, magnetism and chemical action are actually mechanical, has in no single case been obtained. In no single case has the attempt to represent the actual relations by means of a mechanical system so far succeeded that nothing remained over to explain. I grant that for many individual phenomena, the mechanical analogues have been given with more or less success. But all attempts to completely represent the whole of the known facts in any department by means of some such mechanical analogue have resulted without

exception in some unexplainable contradiction between what really happens, and what we should expect from our mechanical model. This contradiction may long remain hidden ; but the history of science teaches us that it sooner or later makes its inevitable appearance, and that all we can say with complete certainty regarding such mechanical similes or analogues—usually termed mechanical theories of the phenomena in question—is that they will doubtless on some occasion fail.

The history of optical theories offers a striking example of these facts. So long as the whole of optics embraced only reflection and refraction, its phenomena could be represented by the mechanical system proposed by Newton, according to which light consisted of small particles which were shot out in straight lines from the radiating object, and obeyed the laws of motion for perfectly elastic bodies. The fact that another mechanical view, the vibration theory of Huygens and Euler, yielded just as much in these respects might well have awakened doubts as to the exclusive ability of the earlier hypothesis to meet the requirements of the case, but it was not able to usurp the latter's scientific position. When, however, the phenomena of interference and polarisation were discovered, Newton's mechanical analogue showed itself to be quite unsuitable, and the other, namely, the *vibration theory*, was considered established, since from its assumptions the chief points at least of the new phenomena could be deduced.

The life of the vibration theory as a *mechanical theory* has also had its bounds, for in our own time it too has been carried to its grave without drum or fife, and its place taken by the electro-magnetic theory of light. A post-mortem examination reveals clearly the cause of death ; it has resulted from the failure of the mechanical parts. The hypothetical ether whose task it was to " beat " had to fulfil its duty under particularly difficult conditions. For the phenomena of polarisation demanded unconditionally that the vibrations should be transversal. Now this presupposes a solid body, and the calculations of Lord Kelvin have finally shown that a medium with such properties as

were thus required of the ether could not possibly be stable, and, as a necessary consequence, can have no physical existence. Doubtless the idea of sparing the now generally received electro-magnetic theory of light a similar fate prompted the immortal Hertz, to whom this theory owes so much, when he expressly declined to see in it anything beyond a system of six differential equations. That the evolution of the theory should end in this point is a far more convincing argument than any I could adduce against the permanent value of the theoretical methods previously followed on mechanical lines.

But you may urge the fruitfulness of these theories. Yes, they were fruitful in so far as they contained correct elements, just as they were harmful on account of the false ones. Which were the right and which were the wrong elements, however, was only revealed after long and dearly bought experience.

The result of our remarks up to the present is in the first place purely negative ; we have learned how *not* to proceed, and it may appear of little use to bring forward such negative results. However we may already note one gain here which many of you will not consider worthless. In this way we discover the possibility of critically correcting a view which in its own time created no small sensation, and caused many of those interested great trouble. I refer to the widely known views first expounded twenty-three years ago by the celebrated Berlin Professor of Physiology, Emil du Bois-Reymond, at the Leipzig meeting of the German Association of Natural Philosophers, and later in some other much-read papers ; views dealing with the prospects of our future knowledge of nature and culminating in the much-discussed *ignorabimus*. In the long controversy which this speech gave rise to du Bois-Reymond has, so far as I can see, victoriously withstood all attacks, and naturally so, since all his opponents have proceeded from the same premises which led him to his *ignorabimus*, and his conclusions stand as firm as the basis upon which he built them. This basis, which meanwhile had been called in question by no one, is the me-

chanical conception of the universe, namely, the assumption that the resolving of phenomena into a system of moving particles is the goal to be aimed at in our explanation of nature. Should, however, this foundation fall—and we have seen that it must—then with it goes the *ignorabimus*, and science is once more free to move onward.

I do not believe that this result will be received with astonishment, for judging by my own experience, no investigator of nature has seriously believed in the *ignorabimus*, although it was not clear where the weak point of the argument lay. Hence the result gained by the rejection of the mechanical conception of the Universe, namely, the banishment of that menacing spectre, may well be of some value to many a thinker unable to find a flaw in the resistless logic of du Bois-Reymond's argument.

What has here been set forth for the sake of clearness with respect to special discussions such as the foregoing, has, however, a far wider significance. The doing away with the mechanical construction of the universe goes down to the very foundations of the whole materialistic conception of things, taking the word materialistic in its scientific sense. If it appears a vain undertaking, ending with every serious attempt in final failure, to give a mechanical representation of the known phenomena of physics, we are driven to the conclusion that similar attempts in the incomparably more complicated phenomena of organic life will be still less likely to succeed. The same fundamental contradictions occur here also, and the assertion that all the phenomena of nature can be primarily referred to mechanical ones cannot even be designated here as a practical working-hypothesis; it is simply incorrect.

This error appears more clearly when viewed in the light of the following fact. The equations of mechanics all possess the property that they still hold good when the sign of the quantity denoting *time* is changed. That is to say, theoretically perfect mechanical processes can take place just as well backwards as forwards. In a purely mechanical world there would be, therefore, no Before and

no After, in the sense of our world ; the tree could return again to the sapling and the sapling to the seed, the butterfly transform itself once more into the caterpillar, and the old man become again a babe. For the fact that this does not occur, the mechanical conception of the world has no explanation to offer, and can have none on account of the already mentioned property of mechanical equations. The evident irreversibility of actual natural phenomena proves, therefore, the existence of processes which cannot be represented by mechanical equations, and with this statement the judgment on scientific materialism is passed.

We must accordingly, and this appears to follow with absolute certainty from these considerations, give up all hope of getting a clear idea of the physical world by referring phenomena to an atomistic mechanics. But, perhaps one of you will say, what means shall we have left of picturing to ourselves what really occurs in nature when the conception of atoms in motion is abolished ? To such a question I would answer : Thou shalt not make unto thyself any image or likeness. Our task is not to view the world in a more or less bedimmed and crooked mirror, but as directly as the nature of our minds will permit. To co-ordinate realities, *i.e.*, definite and measurable quantities, so that when certain of them are given the others can be deduced, is the problem set before science, and this problem cannot be solved by assuming as substratum any hypothetical analogue, but only by the determination of the mutual relations existing between measurable magnitudes.

Undoubtedly this way is long and tiring, yet it is the only permissible one. But we need not tread this path with bitter self-renunciation hoping that it will finally lead our grandchildren to the longed-for summit. No, it is we who are the fortunate ones, and the most hopeful bequest which the departing century can bestow on the one that is just dawning is the replacement of the mechanical by the "energetical" conception of the universe.

I consider it of the greatest importance to state here that all this is by no means a novelty, a production of to-day. No, for half a century it has, though unrecognised,

been in our possession. Here indeed if anywhere we may fitly apply the words: "Geheimnissvoll offenbar" (mysteriously revealed). Daily could we read it and we understood it not.

When Julius Robert Mayer fifty-three years ago first discovered the equivalency of the various natural forces, or as we now say, the various forms of energy, he had already taken an important step in the critical direction. But according to an ever-recurring law in collective thinking, a new idea is never accepted in the pure and unsullied form in which it is offered. He who has not inwardly experienced its development, but who has received the knowledge from without, seeks above all to adapt that which is new as well as possible to his previous notions. In this way the new idea is marred, and, even if not actually perverted, nevertheless robbed of its best power. Indeed so active is this peculiarity of thought that it does not even leave free the discoverer himself. Copernicus' powerful intellect sufficed indeed to cause sun and earth to change places in their motions, but failed to conceive the motions of the other planets in their simplicity; for these he retained the traditional theory of the epicycles. We see the same thing in Mayer's case. The task of the succeeding generation consisted, as is almost always the case, not simply in reaping the results of the new doctrine, but rather in separating piece by piece the arbitrary and extraneous additions until finally the fundamental idea should appear again in its pure simplicity.

We observe also in our case a similar development. When J. R. Mayer had set forth the law of equivalency his idea of equivalent transmutability of the different forms of energy was in its simplicity too strange to be directly accepted. Indeed the three scientists to whom we are mostly indebted for the working out of this law—Helmholtz, William Thomson and Clausius—all three believed that the law could be "explained" by assuming that the different forms of energy were fundamentally the same, namely, *mechanical* in nature. In this way what appeared to be the most urgent need was satisfied, namely, a direct

connection with the dominating mechanical conception of nature. But a fundamental part of the new thought was thereby lost.

Half a century has been necessary to mature the conviction that this hypothetical addition to the law of energy is in reality no deepening of insight but a renunciation of its most important aspect : its freedom from every arbitrary hypothesis. It was not, however, the recognition of this general fact which actually brought about this advance, namely, the rejection (as far as it has gone) of the mechanical explanation, but rather the final failure of all attempts to interpret satisfactorily by the mechanical treatment the phenomena connected with the remaining forms of energy.

But you will be impatient to learn how it is to be possible by such an abstract idea as energy to form a conception of the universe which shall be comparable, in clearness and intuitiveness, with the mechanical one. The answer ought not to be difficult. What do we know of the physical world? Obviously only what is vouchsafed us through our organs of sense. But under what conditions are these organs set in action? Turn the matter as we may, the only principle we find common to all is this : *The Organs of perception react in response to differences of energy between them and the surroundings.* In a world in which the temperature was everywhere that of our bodies we should have no experience of heat, just as we have no perception of the constant atmospherical pressure under which we live. Not till we have produced a space of different pressure do we become aware of its existence.

Well and good, this you will be ready to admit. But you will not be so ready to abandon matter, for energy must of course have a *carrier*. But I ask in return : Why? Since our total knowledge of the outer world consists in its energy relations, what right have we to assume in this very outer world the existence of something of which we have had no experience? But energy, it has been urged, is only something thought of, an abstraction, while matter is a reality ; exactly the reverse, I reply. Matter is a thing

of thought which we have constructed for ourselves (rather imperfectly) in order to express that which is lasting in the changeableness of phenomena. Now that we begin to grasp that the Actual, *i.e.*, that which *acts* upon us, is energy alone, we must inquire in what relation the two conceptions stand to one another, and the result is undoubtedly that the predicate of reality can be affirmed of Energy only.

This decisive aspect of the new conception will perhaps stand out more clearly if I sketch the development of the idea in question in a short historical *résumé*. We have already seen that progress in science is characterised by the discovery of ever more general invariants, and I have also indicated how the first of these invariable quantities, mass, was extended to matter, *i.e.*, mass accompanied by volume, weight, and chemical properties. This conception was, however, obviously insufficient to embrace phenomena in their continual changeableness, and from Galileo's time onwards the idea of force has been added in order to suit this phase of nature. But force lacked the property of constancy, and after *vis viva* and work had been found to be mechanical functions exhibiting the properties of partial invariants, Mayer discovered in energy the most general invariant which rules the whole dominion of physical forces.

In accordance with this historical development, matter and energy continued to exist side by side, and all that could be said about their mutual relation was that they occurred for the most part together or that matter was the carrier or holder of energy.

But are matter and energy things essentially different from one another, as perhaps Body and Soul? Or is not rather all that we know and say of matter already contained in the idea of energy, so that we can represent with this latter quantity the totality of phenomena? According to my conviction there can be no doubt as to the answer. Hidden in the conception of matter are the following ideas: first of all, mass, that is, the capacity factor of kinetic energy; further, the occupation of space or volume energy; again, weight or that particular kind of distance energy.

which appears as gravitation ; and finally chemical properties, *i.e.*, chemical energy. It is always a question of energy alone, and if we imagine the various kinds of energy removed from matter there remains *nothing*, not even the space it occupied ; for space makes itself known only through the expenditure of energy which the penetration into it requires. Matter is therefore nothing but a group of various forms of energy co-ordinated in space, and all that we try to say of matter is really said of these energies.

What I am endeavouring to lay down is so important that you will pardon my venturing to approach the subject from another quarter. Allow me to use for this purpose the most drastic illustration I can find. Imagine that you receive a blow from a stick. What do you feel, the stick or its energy?

The only possible answer is : The energy. For the stick is the most harmless thing in the world as long as it is not wielded. But we can also knock ourselves against a stationary stick. Certainly. What we perceive, as already stated, are *differences* of energy conditions relative to our sense organs, and it is consequently immaterial whether the stick moves towards us or we towards the stick. If both we and the stick are moving in the same direction with the same velocity, the latter has no further existence for our sense of feeling, for it can no longer come in contact with us and effect an exchange of energy.

These considerations show, I hope, that *all* that we have until now been able to express by the ideas of Matter and Force—and indeed much more besides—may actually be expressed by the idea of energy. It is a question simply of transferring to this conception those properties and laws which were formerly ascribed to matter and force. We gain further the enormous advantage of doing away with the contradictions which were attendant on the former method of treatment, and to which I alluded in the earlier part of my paper. By making no assumption as to the relation between the different forms of energy, except that given by the law of conservation, we leave ourselves

free to study objectively the various properties of these forms of energy. We can, further, by rational consideration and arrangement of these properties, establish a system which shall represent explicitly not only the similarities, but also the differences in these forms of energy, and which will therefore lead us much further scientifically than would be possible when slurring over their differences through the hypothetical assumption of their "inner" identity. A good illustration of the meaning I intend to convey may be found in the kinetic hypothesis of gases which at present enjoys almost universal recognition. According to this hypothesis the pressure of a gas arises from the blows delivered by the moving particles. Now pressure is a quantity which possesses no special direction : a gas exerts pressure in all directions equally ; but a blow is caused by a moving object, and this motion has a definite direction. Consequently one of these quantities cannot be referred directly to the other. The kinetic hypothesis gets round this difficulty by the assumption that the blows occur uniformly in all directions, whereby the vector-property really possessed by the blow is artificially done away with. In this case the artificial adaptation of the properties of the different energies is successful, but in other cases it is not completely possible. The factors of electrical energy, potential and electrical quantity, form a case in point—quantities which I propose to call *polar*, i.e., they are characterised not only by a numerical value but also by a sign in such a way that the sum of two equal values with opposite signs is equal to zero and not to their double value. In mechanics the purely polar quantities are unknown, and this is why all attempts to set up even a partially workable mechanical hypothesis for electrical phenomena must essentially fail. Should we succeed in contriving a mechanical magnitude with polar properties (as is perhaps not impossible, and certainly worthy of careful consideration) we should have the means wherewith to picture to ourselves mechanically at least a few phases of electrical phenomena. We may say with certainty that it will be a question of a few only, and that the imper-

fection of all mechanical hypotheses will show itself here again and will prevent the complete carrying out of the idea.

But even if the laws of natural phenomena may really be reduced to the laws of the corresponding forms of energy, what advantage do we gain therefrom? First, the very considerable one, that a science free from hypothesis becomes possible. We seek no longer forces whose existence we cannot prove between atoms which we cannot observe, but we judge a process by the kind and quantity of the vanishing and appearing energies. *These* we are able to measure, and all that it is necessary to know may be expressed in this manner. What an enormous general advantage this is, will be clear to every one whose scientific conscience has suffered under the continual amalgamation of facts and hypothesis which the physics and chemistry of to-day offer us as rational science. Energetics offers us a means of fulfilling in its true sense the demand of Kirchhoff so oft misunderstood, namely, the substitution of the description of phenomena for the so-called explanation of nature. With this freedom from hypothesis appears a methodical unity which, it may be unhesitatingly affirmed, has up till now never been attained. I have already referred to the philosophical significance of this unity of principle in the conception of natural phenomena; although obvious from the very nature of the case, I may still call attention in particular to the enormous advantage with regard to the teaching and understanding of science which accrues from this philosophical unification. To illustrate by an example: we may assert that all equations without exception which connect two or more different classes of phenomena must necessarily be equations between energy values, others are altogether impossible. This follows as a necessary result from the fact that besides the intuitive ideas of space and time, energy is the only quantity which is common to each and every class of phenomena; and therefore energy quantities are the only ones which can possibly be equated between these classes.

I must, unfortunately, refrain from entering into the

many relations—some already known, some new—which may by this principle be directly written down, but which formerly could be deduced only by more or less clumsy calculations. I must also forbear from discussing the new phases which have been exhibited in the light of general energetical considerations by the other earlier laws of thermodynamics—the most extended branch of Energetics. All these things must indeed be so if what I said concerning the importance of this new way of considering nature is well founded.

There is a final question which I would not like to pass untouched. When we once succeed in grasping in its pure entirety a fruitful and important truth we are only too apt to look upon it as all-comprehensive. This mistake we see daily committed in science, and the conception to the combating of which I have devoted the half of the time allowed me has arisen from exactly such a cause. We shall forthwith have to ask ourselves the question: Is energy, necessary and useful as it is for the understanding of nature, also *sufficient* for this purpose? Or are there phenomena which cannot be completely represented by the known laws of energy?

I do not think I can better justify the responsibility which I have by these remarks incurred towards you than by emphasising the fact that this question must be answered in the *negative*. Immense as are the advantages possessed by the energetical conception of the universe over the mechanical or materialistic, it seems to me, nevertheless, that already certain points may be noted which are not covered by the known laws of energy, and which therefore point to the existence of principles which extend beyond these. Energetics will remain beside these new laws; but it will not be in the future, as we must to-day consider it, the most comprehensive principle ruling natural phenomena; it will perhaps appear as a special case of a still more general relation, of the nature of which we can at present have scarcely an inkling.

I am not afraid of having lowered by what I have said the value of that mental progress which we were discuss-

ing ; I think I have rather raised it. For once again are we met by the fact that Science may never recognise bounds to her progress, and that amidst the struggles for some new possession her eyes must not become blinded to the fact that beyond the territory she is striving to conquer still wider plains extend which later must also be subdued. Let us have done with the time when the smoke and dust of battle confined our vision to the narrow limits of the combat. To-day that is no longer allowed ; to-day we fire with smokeless powder—or rather ought to do so—and have, therefore, with the possibility, also the duty not to fall into the errors of past periods.

WILHELM OSTWALD.

## THE DIAGNOSTIC AND THERAPEUTIC USE OF MALLEIN.

THE early investigators who raised the study of micro-organisms to the rank of a science were, for the most part, content with establishing the pathogenic or non-pathogenic characters of bacteria, and morphological considerations played an important part in the chain of evidence by which it was proved that definite species of bacteria may stand in direct causal relation to disease. At the present time, however, the growth of knowledge concerning bacteria chiefly takes place by the application of methods which are identical with those which have created physiology, and the interest which surrounds the discovery of a new micro-organism soon disappears, because researches conducted upon physiological lines are absolutely necessary before the full importance of the discovery can be appreciated. The conditions which govern its spread and mode of reproduction have to be determined, but, above all, the exchange of material which a microbe exhibits needs investigation, and it is this problem which has attracted so many workers.

The products of bacterial life have in several cases been proved to be even more harmful than the microbes themselves, while, on the other hand, filtrates of bacterial cultures have been employed to confer immunity, a state which, when established, may be transferred from one animal to another of the same or even a different species. Apart from changes in the culture media which are produced by the exchange of material consequent on bacterial life, the microbes themselves may die, and by subsequent disintegration give rise to substances which possess neither toxic nor protective properties, but are capable of causing profound constitutional changes among which fever and local inflammatory disturbances are prominent symptoms. To this class of bodies belong those bacterial proteïnes which Buchner, Römer and others have investigated, and pro-

bably tuberculin and mallein may be included in the same group. The latter is obtained from cultures of bacillus mallei, the specific micro-organism of glanders, a disease especially fatal to horses and easily communicable from them to other animals by direct inoculation. The large carnivora in menageries, lions, tigers and leopards, also succumb after the ingestion of glandered horse flesh (1), though it is still an open question whether a true infection occurs at the surface of the uninjured intestine, since the possibility of minute wounds of the mucous membrane produced by splinters of swallowed bone cannot be excluded. Babes and Cornil have, however, proved that cultures of bacillus mallei incorporated with vaseline or lanoline can be rubbed into the intact skin, conjunctiva or nasal mucous membrane and so produce glanders, and the former observer considers that infection may naturally occur by the entrance of micro-organisms into the body by way of the hair follicles.

Like other infective diseases glanders in the horse, man, or other animals may run an acute or chronic course, and an animal suffering from this malady may exhibit clinical signs which are insufficient to establish a definite diagnosis. Since the disease is common among horses, and apart from other considerations these are the animals which chiefly furnish antitoxic serum for the treatment of diphtheria and tetanus, it is a matter of the utmost importance to definitely ascertain if possible whether an individual is suffering from expressed or latent glanders. Mallein has been extensively employed both in this country and abroad to answer this question before the animals are subjected to the process for conferring immunity.

Many years before the connection between specific micro-organisms and infective diseases was clearly made out, Youatt recommended that doubtful cases of glanders should be diagnosed by reproducing the disease in the ass by inoculation with the nasal discharge of a suspected animal. The discovery of a specific microbe by Löffler and Schütz and its characteristic growth on potato firmly established the value of this method, and as an experimental

animal the guinea-pig or cat may be chosen. The behaviour of bacillus mallei in the frog is so peculiar that Sacharow (2) advises the introduction of pieces of suspected material into the abdominal cavity of this animal. In fifty-eight experiments either bouillon-cultures of bacilli or pus from fresh glanders nodules were injected. In no single case did any frog become diseased, but after intervals of from two to fifty-five days the animals were killed, and without exception pure cultures of bacillus mallei could be obtained from the liver, spleen, kidneys or blood; the bile especially contained countless numbers of bacilli. This observer has not practically tested the value of his method with the nasal secretion where numerous other micro-organisms are associated with bacillus mallei, but the suggestion of Straus that the male guinea-pig should be used has frequently been followed in the diagnosis of doubtful cases. In this animal a local suppuration can be set up in two to three days after the peritoneal injection of suspected material, and specific microbes can be separated from the pus. In undoubted cases of glanders, and also in those where no ulceration or nasal discharge exists, excision of suspected nodules and application of the methods briefly indicated above may convert doubt into certainty; but the employment of mallein as a means of diagnosis in equivocal cases promises to be of even greater value, and sufficient experimental work has now been carried out in England, France, Germany and Russia to permit some conclusions to be drawn on this subject.

About four years have now elapsed since Kalning of Dorpat (3) prepared a fluid from cultures of bacillus mallei that had been raised upon potato. The growth was removed, thoroughly mixed with water, and the mixture then heated for twenty minutes at a temperature of  $120^{\circ}$  C. for four successive days. After having been left in the incubator for two days at  $39^{\circ}$  the liquid was filtered and the filtrate sterilised by heating to  $120^{\circ}$  for fifteen minutes. Using the term introduced by Babes (4) this fluid is known as mallein. In April, 1890, Helman had previously made a short communication on the use of

an extract of *bacillus mallei* as a means for conferring immunity, and he noticed that a definite rise in body temperature and local swelling followed a subcutaneous injection. In the succeeding year he more particularly indicated its value as a means of diagnosis. Both these Russian observers worked independently with the aim of rendering animals immune to glanders, and published their results before Koch made his communication on tuberculin, but this gave an enormous impulse to the study of mallein and various solid and fluid preparations of this substance have now been obtained. Pearson (5), Preusse (6) who followed Koch's procedure for tuberculin, Johne (7), Gutzeit (8), Preisz (9), Bonome and Vivaldi (10), Malzew (11), Macfadyean (12), Roux (13), Foth (14) and Kresling (15) among others have prepared mallein, though at the present time in France, Russia and Germany, mallein of Roux, Preusse and Foth is chiefly used. Two of these are liquids and the last is a powder with a faint yellow tint.

Mallein like tuberculin obviously must consist of soluble bodies derived from the microbe itself and from the products of bacterial activity as well as substances in the original culture media, and repeated attempts have been made to isolate a specific body from this complex material. Dialysis of fluid mallein shows that both the substances which remain and those which pass through the membrane are physiologically active, and an alcoholic precipitate of mallein acts precisely like the original material (15). A chemically pure mallein has not yet been seen, and attempts to obtain such a body from proteid-free nutrient media have hitherto been failures (16). Mallein undoubtedly contains nitrogenous bodies some of which belong to the proteid group, such as the bacterial proteïnes and albumoses which are possibly identical, or as Buchner points out the proteïnes contain albumoses. Both these substances are capable of exciting fever when injected into animals, and numerous bacteria besides *bacillus mallei* can produce them. If albumoses are separated from a filtrate, injection of these produces less febrile disturbances than the original filtrate (17). Matthes has recently attempted to decide the ques-

tion whether albumoses are only by-products or the active fever-producing principle. He obtains these bodies not by the activity of micro-organisms but by artificial gastric and pancreatic digestion, and finds that the injection of 3-1 gramme of deutero-albumose under the skin of a healthy guinea-pig originates a fever which lasts from seven to fifteen hours (18). Other experiments conducted on the same lines lead this observer to the conclusion that an albumose is the real phlogogenic agent in such preparations as tuberculin and probably mallein. It is necessary to be cautious in inferring this since it is an undecided question whether there is one specific substance produced by all bacteria, and, further, guinea-pigs are exceedingly sensitive to bacterial products which act differently or may cause no effect in other animals.

The action of various bacterial protéines and mallein has been recently investigated by Schattenfroh (19). The protéines were obtained from potato-cultures of Friedländer's pneumobacillus, bacillus pyocyaneus, and the bacillus of rhinoscleroma, by methods similar to those originally employed by Buchner. These were contrasted with Foth's malleinum siccum, and a protéine obtained from cultures of bacillus mallei. The experiments were conducted on healthy guinea-pigs and on others which, having been inoculated with bacillus mallei, were in a state of acute glanders. He finds that the rise of temperature which succeeds an injection of mallein occurs with all the other protéines, and also with a peptone which can be artificially made from fibrin or vegetable albumin. Both glandered and healthy guinea-pigs react in this way, but the febrile attack, though more intense in diseased animals, is not different in character. The specific protéine of bacillus mallei is also found to act precisely like the protéines of other micro-organisms, and this is in accord with the researches of Buchner, who contends that the protéines of both pathogenic and non-pathogenic bacteria have an equal faculty for producing fever. It is, therefore, sufficiently obvious that Schattenfroh considers that mallein has no essential specific action on glandered animals in consequence of the presence of a

peculiar protein, but that other bodies associated with this may assist to produce a reaction which is considered as diagnostic.

These experimental results were obtained by working with one species of animal, and, according to Schindelka (20), they are not true for horses. On injecting proteins identical with those employed by Schattenfroh into three horses free from glanders, a considerable febrile attack was produced, and on a glandered horse the effect was negative. Mallein acted in an inverse manner, and this observer considers that inquiries into the relative value of mallein and other bacterial products only strengthen the evidence in favour of mallein.

The interest which attaches to bacteriological research lies in part, if not wholly, in the solution of the problem of immunity, and in the experimental work which directly aids in the treatment of disease. In glanders neither of these aims has as yet been accomplished. The results obtained by Babes, who claims to have rendered guinea-pigs immune to glanders by treatment with minute injections of mallein, have not been confirmed. According to the same observer guinea-pigs can also be cured of glanders by administration of this substance; and two horses suffering with the chronic form of the disease were also cured. The majority of observers are, however, agreed that no therapeutic effect follows treatment with mallein. Favourable results may follow, but since spontaneous recovery from this disease may take place a possible fallacy is not excluded. Schattenfroh and others have shown that mallein has no therapeutic power, and in this as well as in many other characteristics this substance resembles tuberculin.

As a diagnostic measure mallein appears to have an assured position. A recent paper, published by Foth (21) last August, reviews this question at length. Nearly all observers point out that animals suffering with acute or chronic glanders, or even with the mild condition spoken of as latent, may exhibit a reaction to small doses of mallein. The symptoms produced in glandered horses, according to

Nocard, may be grouped into organic and thermic, and these may last twenty-four to thirty-six or even forty-eight hours (22) after a subcutaneous injection. A variable amount of stupor and prostration follows, and at the site of injection an inflamed swelling which shows no tendency to suppurate may form. Assuming that the animals have no initial fever, Nocard considers that the thermic effects following injection may be classified in three groups according to the intensity of the febrile disturbance, which may vary from  $^{\circ}2$  to  $^{\circ}2$  C. above the normal, this being  $37^{\circ}5$  to  $38^{\circ}$  C. for the horse. Schindelka of Vienna (23), whose experiments were made with Foth's mallein, especially points out that a "typical" temperature curve is yielded by glandered animals on injection of 1 gramme of mallein. If the temperature reaches or exceeds  $^{\circ}2$  C. above the normal, and if from this level the temperature slowly falls, the animal is certainly glandered. Even if a healthy animal or one suffering with pneumonia or other pulmonary diseases reacts with a fever of  $^{\circ}2$  C., the normal temperature is reached with an abrupt and not a gradual fall. Foth has given a *résumé* of the experiences of mallein injection. Four preparations of this substance were employed: a mallein derived from cultures of bacillus mallei on potato (Preusse of Dantzig and Preisz of Buda-Pest), from bouillon cultures (Roux of Paris, Kresling of St. Petersburg), and the malleinum siccum of Foth. Macfadyean in this country has also employed mallein of Roux and a preparation obtained by himself from bouillon cultures. The results may be arranged in the following manner, and these appear to show that even if an injection of mallein is not an infallible means of diagnosis, it is certainly one of unrivalled value when contrasted with the ordinary clinical and bacteriological methods of investigation.

A. Experiments with Preusse's or Preisz's mallein.

Total number of horses injected . . . .	457
Reaction to mallein $^{\circ}1$ C. and over 303	{ $^{259}$ glandered. 44 not glandered.
Reaction slight or negative . . . . 154	{ $^{132}$ not glandered. 22 glandered.

## B. Experiments with Kresling's mallein.

Total number of horses diagnosed with

mallein . . . . . 658

Marked reaction in 230, of these 14 killed, all glandered.

Slight " 138 " 7 " "

Negative " 290 " 1 killed, healthy.

C. Experiments with the mallein of Roux. These have been chiefly carried out by Nocard of Alfort at the horse dépôt at Montoire, and at the stables of the Compagnie l'Urbaine in Paris.

## Experiments at Montoire.

Total number of horses injected with mallein, 233. Each animal was injected three times at intervals of a month.

Group i. Reaction Temp.  $1^{\circ}9^{\circ}-2^{\circ}$  C... ii. " "  $1^{\circ}-1^{\circ}9^{\circ}$  C... iii. " " less than  $1^{\circ}$  C.

Ninety-two horses from all these groups were killed and examined. All from group i. were glandered and eleven others from groups ii. and iii.

## Experiments in stables of Compagnie l'Urbaine.

Total number of horses subjected to mallein 4348

Horses proved to be glandered . . . . . 523

Reaction temperature of these :—

 $3^{\circ}$  C. and over . . . . . 45 $2^{\circ}5^{\circ}-2^{\circ}9^{\circ}$  C. . . . . 96 $2^{\circ}-2^{\circ}4^{\circ}$  C. . . . . 240 $1^{\circ}5^{\circ}-1^{\circ}$  C. . . . . 142

D. Schindelka, Rudovsky and others have used the malleinum siccum of Foth.

Horses injected . . . . . 669

Horses examined post mortem . . . . . 252

Horses which reacted by fever of  $2^{\circ}$  C. and over,  
96 per cent.

Horses which reacted negatively, 4 per cent.

All horses which reacted by  $2^{\circ}$  C. and over were  
proved on post mortem to be glandered.

All horses which reacted by less than  $1\cdot3^{\circ}$  C. were proved to be free from glanders.

All horses reacting by temperatures  $1\cdot3^{\circ}$ - $1\cdot9^{\circ}$  C. were on autopsy found to be either glandered or not in almost equal proportion.

E. The experiments of Macfadyeian and Hunting (24) were made with Roux's mallein on thirty-nine horses. At the time of their experiments London had the unenviable notoriety of possessing more glandered horses than any other city in Europe. Subsequently the former observer continued his experiments on fifty more animals, using mallein prepared by himself, by Foth and by Roux (25). He considers that mallein is of incomparable diagnostic value, and even if it is not an absolute method, this offers the only possible solution for obscure cases. If the temperature of a fever-free animal reaches  $40^{\circ}$  C. and local inflammation occurs at the site of injection the animal is almost certainly glandered. A rise of  $1^{\circ}$  C. with local symptoms furnishes evidence of probable disease, but if injections of mallein are carried out on horses that have fever the indications to be drawn from the experiments are uncertain.

All work that is still in the experimental stage can only be strengthened by continued research, and that undertaken by Schütz (26) and Prüs does not accord with the favourable results obtained by Semmer, John, Heyne and others. The former observer used the mallein of Preusse in doses of  $\cdot5$  c.c. on fifty-eight horses: all were killed and twenty-two examined post mortem. Fifteen of these had given typical mallein reaction, that is to say a rise of temperature up to  $1\cdot5$  C. and higher with a succeeding gradual fall. Seven horses had reacted with a rise of  $1^{\circ}$ - $1\cdot4^{\circ}$  C. No single animal was glandered. This stands in striking contrast to the results of the majority of observers, although Prüs (27) states that mallein has no specific influence in glandered animals and possesses no diagnostic power. The discrepancies which exist on this question even if fully recognised leave no doubt that mallein has a very definite value in diagnosis. The conflicting statements of Schütz

may well depend on the quality of the mallein used. Even if this is not the case the experiments only show that non-glandered animals may respond with rise in temperature, and it has repeatedly been noticed that animals suffering with acute respiratory troubles may give a reaction which resembles the specific effect of mallein.

In veterinary practice tuberculin is freely used as a diagnostic measure for cases of bovine tuberculosis, and Arloing (28) has studied the effect of injections of pneumobacillin in suspected pleuro-pneumonia. Neither of these bacterial products appears to possess any therapeutic value, and the same is certainly true for all the various preparations of mallein. The employment of this substance for therapeutic purposes appears useless, but these researches have at the same time shown its value as a means of diagnosis in glanders. A considerable literature deals with this question, and Commissions (29) have reported in favour of its use. Even if it is admitted that the experimental work is not absolutely convincing it may be fairly urged that in the majority of cases where the clinical symptoms are obscure, injections of mallein offer the surest test by which doubtful cases can be recognised.

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GEORGE A. BUCKMASTER.

## THE SPACE RELATIONS OF ATOMS.

(Concluded.)

THE coincidence of optical activity with molecular dissymmetry having been established, as regards, at least, the great majority of compounds of the type  $\text{CR}'\text{R}''\text{R}'''\text{R}^{\text{iv}}$ , the question arose : Can the degree of asymmetry be measured by the degree of optical activity ?

But in view of the fact that the change of rotation resulting from a change of conditions (temperature, wave-length of light, solvent, concentration) is not the same for different substances, the preliminary question arose : Under what conditions can comparable numbers be obtained for the optical activity of various substances ?

The most important variations are those produced by the nature and proportion of the solvent ; in the attempt to avoid these variations by examining the pure substance, a greater difficulty arises from the action which the molecules of the substance itself are then free to exert on one another. This compels a resort to dilute solutions, and the difficulties here encountered are greatly diminished if we consider the dissolved substances as divided into two classes, electrolytes and non-electrolytes—a division forced upon us by the application of the theory of electrolytic dissociation.

As regards electrolytes the theory teaches that different salts of the same active acid or base possess in dilute solution the same molecular rotation, because they contain approximately the same number of active ions ; this identity of rotation is the law experimentally established by Oudemans and Landolt.

For non-electrolytes the results obtained lack precision, because the molecular weight of the active body, and the possible action of the solvent, have in many cases still to be determined.

The effect of temperature and of wave-length is of minor importance, and, by using the same solvent in the same proportion under similar conditions, comparable results may be

obtained, at least for bodies of similar constitution. And the attempt to apply these results to the determination of the degree of molecular dissymmetry has been made by Guye.

Assuming for the body  $CR_4$ , the form of a regular tetrahedron, it will have six planes of symmetry, at the intersection of which will be the centre of gravity of the molecule. In a body  $CR'R''R'''R^{iv}$  the C.G. of the molecule is removed from all the six planes by distances  $d^1, d^2, d^3, d^4, d^5, d^6$ . The product of these distances is the measure of the dissymmetry (*i.e.*, of the activity of the molecule).

This theory fulfils the condition that when two groups become identical the activity must vanish, for in this case one of the distances,  $d^1, d^2$ , etc., becomes *nil*, and their product is likewise *nil*.

The distances  $d$  will be determined in the first place by the relative weights and distances of the groups R, and as it is the relative weights alone which can at present be determined, the first step was to see how far the distances  $d$  depend on the difference of the weights R : in short, whether for the equation

$$P = d^1 \times d^2 \times d^3 \times d^4 \times d^5 \times d^6$$

we may substitute

$$P = (R' - R'')(R' - R''')(R' - R^{iv})(R'' - R''')(R'' - R^{iv})(R''' - R^{iv}),$$

where P is the "asymmetry-product" or the measure of the dissymmetry of the tetrahedron.

Assuming this formula we get the following results :—

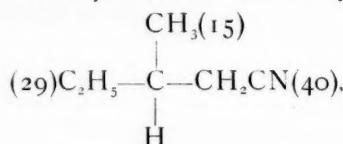
(1) If two of the groups R change places the activity remains the same, but the sign changes, as the existence of isomers of equal and opposite activity demands.

(2) If the group-weights change, but their order remains the same, the magnitude of the rotation will change but not the sign.

(3) If the heaviest group, say  $R^{iv}$ , be replaced by groups of constantly decreasing weight the rotation (say positive) will decrease, and will reach *nil* when  $R^{iv}$  becomes equal to the next heaviest group  $R''$ . Beyond this point the rotation (now negative) will increase, declining again to *nil* when  $R^{iv} = R'$ , and changing sign again when this point is passed,

and so on ; so that as  $R^iv$  gradually passes from the maximum to the minimum the sign of the rotation changes four times.

These conclusions have been tested in the case of over forty derivatives of amyl alcohol. If in amyl cyanide,



the largest group,  $\text{CH}_2\text{CN}$ , be replaced by others of weight exceeding 29, the molecule remains in almost every case dextro-rotatory, and in most cases the rotation increases with the mass, as shown by the following examples :—

	amyl cyanide.	amyl chloride.	caproic acid.	amyl bromide.	amyl iodide.
$\text{CH}_3$					
$\text{C}_2\text{H}_5$	-	-	-	-	-
$\begin{array}{c} \diagup \\ \text{C} \\ \diagdown \end{array}$	$\text{CH}_2\text{CN}$	$\text{CH}_2\text{Cl}$	$\text{CH}_2\text{COOH}$	$\text{CH}_2\text{Br}$	$\text{CH}_2\text{I}$
H	40	49.5	59	94	141
$a_p$	+ 1° 16'	+ 1° 6'	+ 3° 20'	+ 4° 24'	+ 8° 20'

But on the other hand we have

$$\begin{array}{lll} \text{amyl alcohol} & -\text{CH}_2\text{OH}(31) = & -5^\circ 2' \\ .. \text{ amine} & -\text{CH}_2\text{NH}_2(30) = & -3^\circ 30' \\ .. \text{ aldehyde} & -\text{COH} \quad (29) = & +0^\circ 42'. \end{array}$$

So that the change of sign which should take place only below 29 begins at 31.

Thus, as Guye points out, the molecular dissymmetry depends largely, but by no means exclusively, on the weight of the groups. The study of other compounds (esters of tartaric, glyceric, and valerianic acids) leads to the same conclusion. In particular it is noticed that equality in the weight of two different groups is not, as the formula demands, accompanied by inactivity. Thus ethyl-malic acid,



exhibits dextro-rotation, although  $\text{C}_2\text{H}_5\text{O}(45) = \text{COOH}(45)$ . Similarly amyl aldehyde remains slightly active, although  $\text{COH}(29) = \text{C}_2\text{H}_5(29)$ .

Again, propyl-glycerate is more active than iso-propyl-glycerate. It might be supposed that this was due to the

moment of the chain  $\text{CH}_3\text{CH}_2\text{CH}_2$ — about the central carbon atom being greater than that of the chain  $\begin{array}{c} \text{CH}_3 \\ | \\ \text{C} \\ | \\ \text{CH}_3 \end{array} > \text{CH}$ ; unfortunately for this explanation it is found that iso-propyl-tartaric acid is more active than propyl-tartaric acid; and Freundler (*Bull. Soc. Chem.* [3], ii., 305 and 366) finds that in general the calculation of the moments of the carbon chains gives no satisfactory results.

It remains to mention the theory of Crum Brown, who proposes to determine, for each of the radicals linked with carbon, a function K, the "rotation-equivalent," a function which perhaps varies with the temperature, etc.; the difference between these functions would determine the rotation of the molecule. The rotation-equivalent is considered by Crum Brown as a function of the composition and constitution of the radical, not necessarily proportional to the mass and the distance of the centre of gravity from the centre of the carbon atom. This hypothesis, as its author observes, takes no account of the mutual action of the radicals, and it is unlikely that a radical will in every compound have the same rotation-equivalent, its distance from the central carbon atom not being always the same. In closely allied compounds, however, it seemed possible that the effect of such differences would be inappreciable, that in them the rotation-equivalent of each radical might be constant. Acting on this supposition, J. Wallace Walker<sup>1</sup> has recently found that in the ethereal lactates there is a constant increase of  $5\cdot5^\circ$  in the rotation of the molecule for each addition of  $\text{CH}_2$  to the carboxyl group. In the brom-propionates the same addition causes a much greater increase of rotation. Thus ethyl brom-propionate has a rotatory power  $14\cdot3^\circ$  greater than the methyl compound, and propyl brom-propionate  $14\cdot2^\circ$  greater than the ethyl compound. Further, almost all bromine derivatives are found to have a greater rotation than the corresponding chlorine derivatives, showing that the rotation-equivalent of bromine is greater than that of chlorine.

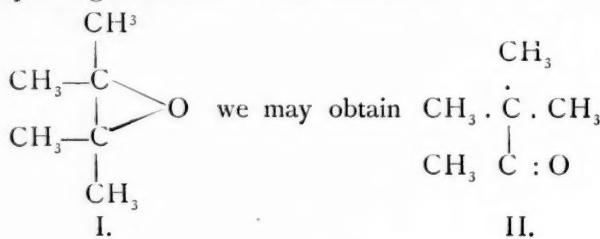
So far our review of stereochemistry has occupied itself

<sup>1</sup> *Journ. Chem. Soc.*, p. 914, 1895.

mainly with stereo-isomerism ; it has concerned itself only with such bodies as could be isolated in numbers unaccounted for by any possible application of structural formulæ. In many cases the configuration attributed to these bodies by the tetrahedron hypothesis has been confirmed by the study of their reactions.

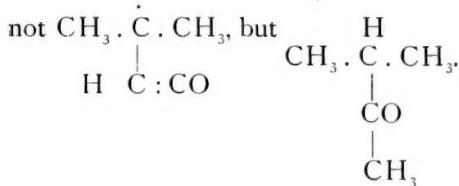
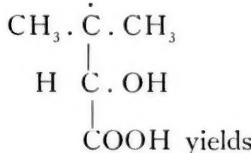
But we have now to consider cases in which the study of reactions has been the first step, and has led to stereochemical theories, such as have been developed more especially by Bischoff under the title of "the dynamic hypothesis". This name, chosen because the object of these studies was to determine the motion of the atoms, as well as their average position, seems appropriate also because the subject of the investigations has been the reactions of bodies, rather than the number of their isomers—chemical dynamics rather than statics.

The phenomenon of ring-formation has already afforded a striking example of the connection between reactions and the space relations of the atoms concerned. The formation of a carbon ring has been seen to depend on the number of its members, and on the relative position (cis- or trans-) of the groups whose interaction closes the ring. But, as Bischoff points out, the nature of the atoms connected with members of the ring not directly concerned in the closing thereof has also an effect. Thus a methyl group substituted for hydrogen in the system of succinic, of maleic, or of glutaric acid facilitates the closing of the ring,—formation of an anhydride. In other cases, however, methyl prevents or renders difficult the ring-formation. Sometimes, indeed, in a compound containing several methyl groups it is easier to obtain a molecular re-arrangement than a simple ring-formation. Thus instead of

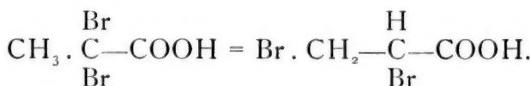


For such a case static formulæ, whether structural or tetrahedral, have no ready explanation. Bischoff's explanation is that in formula II. the methyl groups can oscillate much more freely than in I. It is II. therefore which must be formed according to the "dynamic hypothesis" which states that "those configurations are the most favoured in which the components of the system can oscillate most freely".<sup>1</sup>

In the cases mentioned above, where the methyl groups cause closure of the ring, it is again their effort to gain room for their oscillations which causes them to crowd together the hydroxyl groups, so that expulsion of water with ring-formation follows. The dispersion of the methyl groups is observed also in open chain compounds. Thus  $\beta$ -tri-methyl ethylidene lactic acid



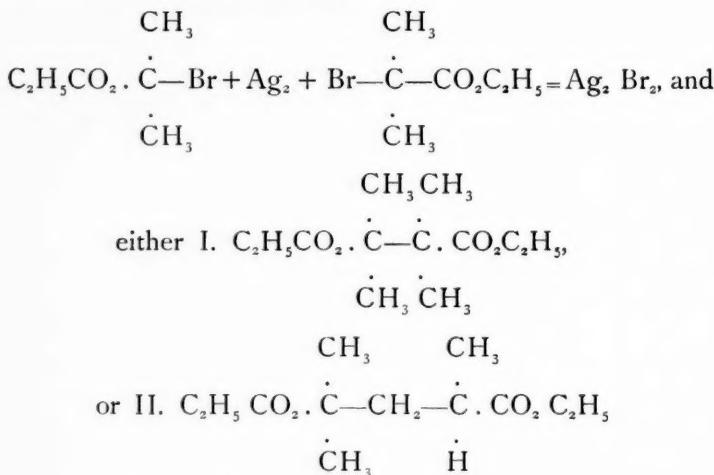
Bromine atoms also tend to separate as widely as possible. Thus  $\alpha$ -di-bromopropionic acid becomes  $\alpha\beta$ -bromopropionic acid



<sup>1</sup> It may be added that as like atoms have like oscillations, they will be the most prone to collide, and in a favoured configuration they must be far removed from one another. Moreover, atoms which though unlike are of like nature (degree of positivity) must to a less degree be far removed from one another.

In the second arrangement the oscillations of the bromine atoms are evidently less subject to mutual hindrance.

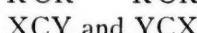
As in intra-molecular so in inter-molecular transformations the same phenomenon is observed. As one example among many it may be noted that brom-isobutyric ether re-acts with silver in two ways, thus—



According to Bischoff the dynamic hypothesis signalises II. as the favoured configuration, and demands that it be formed in larger quantity; but an answer to the question why the unfavoured configuration should be formed at all is still lacking. We may hope, however, with Bischoff, that in time stereochemistry will enable us to foretell the course of "abnormal" reactions just as structural chemistry enables us to foretell the course of ordinary reactions, and we shall then be able to improve the models now in use which are deficient as regards the representation of the distances of the atoms from one another.

In connection with the subject of atomic motion there is to be mentioned in the first place the simple and wide view of Le Bel, which supposes connected atoms or their repulsive zones to glide freely over the surface of one another in every direction, no directive force acting from one to the other. This is not inconsistent with the limitations which the atoms of a molecule may impose on one another in the

way indicated by Bischoff. In one case at least, however, there is a limitation of motion which seems due to a directive force, and which tells in favour of the tetrahedron hypothesis. The existence of the stereomeric inactive trioxyglutaric acids corresponding to the types



$R''$  proves that the

groups attached to the carbon atoms do not rotate about one common axis; *i.e.*, as the tetrahedron hypothesis demands, the lines joining the carbon centres are not in a straight line.

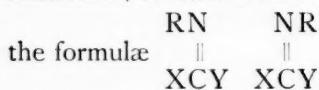
Before leaving the stereochemistry of carbon it is worth while to notice the calculations of O. E. Meyer in his *Kinetische Theorie der Gase*,<sup>1</sup> concerning the arrangement of the atoms in various molecules. According to his results molecules may be divided into four classes: (1) the volume of the molecule is equal to the sum of the molecules of the atoms; (2) the area of the molecule is equal to the sum of the areas of the atoms; (3) the diameter of the molecule is equal to the sum of the diameters of the atoms; (4) for some molecules none of these relations hold. In molecules of the first class we must suppose that the atoms are arranged symmetrically in every direction, so that they occupy as nearly as possible a sphere. Such a molecule according to Meyer is  $\text{CH}_4$ , which may be represented with the four hydrogens symmetrically arranged on the surface of a sphere, and rotating about the carbon atom at the centre—a confirmation of the tetrahedral hypothesis. In molecules of the second class the atoms must be and move in one plane, and the figures obtained for  $\text{NH}_3$  show this to be such a molecule—another confirmation of current theory. An example of the third class is  $\text{H}_2\text{O}$ , which we must therefore suppose to have the atoms arranged in a straight line. HCl satisfies all three of the previous conditions almost equally; this indicates that the two atoms lie so close together that

<sup>1</sup> Breslau, 1877, Maruschke and Berendt.

the short line joining them is almost a point. The fourth class is composed of more complicated molecules, as  $\text{CH}_3\text{Cl}$ ,  $\text{C}_2\text{H}_4$ ,  $\text{C}_2\text{H}_6\text{O}$ ,  $\text{C}_2\text{H}_5\text{Cl}$ , to which, therefore, the form of flattened sphenoids is attributed.

The stereochemistry of elements other than carbon has made little progress, except in the case of nitrogen. Speculations on the space relations of nitrogen compounds have long been rife, but it is only of recent years that they have acquired practical interest. In the case of trivalent nitrogen, as in the case of carbon, it was the discovery of isomers unforeseen by the structural formulæ which led to the new doctrines. These mysterious nitrogen isomers were found par-

ticularly among the oximes,  $\begin{array}{c} \text{R}' \\ \diagup \\ \text{R''} \end{array} \text{C} = \text{NOH}$ , and here it is constantly observed that when  $\text{R}'$  and  $\text{R}''$  are not identical, an isomerism arises which is lacking when identity is established. Thus aldoximes exhibit this isomerism, but it is lacking in  $\begin{array}{c} \text{H} \\ \diagup \\ \text{H} \end{array} \text{CNOH}$ ; again, it is noticed in nineteen non-symmetrical ketoximes but is lacking in the di-phenyl compound. When the number of  $= \text{CNOH}$  groups in the molecule increases, the number of isomers also increases, as in the case of benzil dioxime and phenyl glyoxime. (Sometimes, however, only two isomers can be isolated.) Later, the phenyl hydrazones,  $\begin{array}{c} \text{X} \\ \diagup \\ \text{Y} \end{array} \text{CNNHC}_6\text{H}_5$  and  $\begin{array}{c} \text{X} \\ \diagup \\ \text{Y} \end{array} \text{CNN}$  ( $\text{C}_6\text{H}_5$ )<sub>2</sub>, were found to present similar isomerism, provided always that the groups X, Y, were dissimilar. Observing that this dissimilarity was essential to the occurrence of the isomerism, Hantzsch and Werner were led to explain it by



In one isomer the radical R attached to the nitrogen atom is attracted towards X, in the other towards Y, the nitrogen valences being diverted by these attractions from the plane which, according to reasoning previously given, they ordinarily occupy; and there is always a difference

between the two isomers which may be supposed to correspond to the difference in the attractions X—R and Y—R.

A stereochemical formula for the carbon nitrogen compounds in question is obtained by Van't Hoff by joining the nitrogen triangle to the carbon tetrahedron as shown in figure 12.

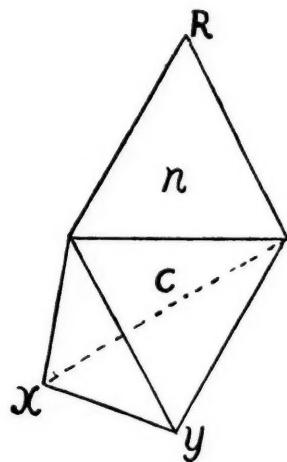


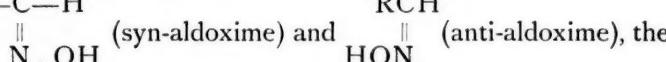
FIG. 12.

Here R is represented in the position it would have if X and Y were identical; when they differ, one or the other isomer results according as R approaches X or Y. There is no evidence to show whether N is or is not attracted to the same side as R.

For the three benzil dioximes Hantzsch and Werner give the formulæ



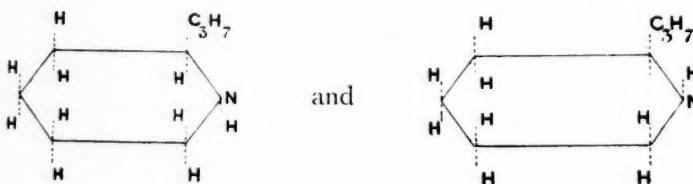
In most cases these chemists have been able by a study of the reactions of the isomers to determine which of the formulæ belongs to each. For instance, of the two formulæ  $\text{R}-\text{C}-\text{H}$  and  $\text{RCH}$



first must be assigned to the isomer which alone yields the nitrile, according to the equation



In ring-compounds a similar isomerism, corresponding to the cis-trans isomerism of the hydrophthalic acids, has been observed. Thus Ladenburg attributes to coniine and isoconiine the formulae



The isomerism of the kreatinines is probably analogous; here as well as with the coniines one of the chief distinctions between the isomers is the difference in solubility of the platinum double salts.

With regard to pentad nitrogen it has already been observed that, united to five different radicals, it causes optical activity. When any two of the radicals are identical the activity disappears; but now another kind of stereomerism may arise. Thus two trimethyl isobutyl ammonium chlorides and two methyl diethyl amyl ammonium chlorides have been formed. When the radicals are smaller this isomerism does not occur; thus there is only one trimethyl propyl and one tripropyl methyl ammonium chloride, probably owing to the mobility of the smaller radicals.

The existence of the active isomers shows that in them the atoms are not in one plane, and the existence of the other isomers shows that an alkyl may occupy either of two positions in a substituted ammonia. The inactivity when two radicals are identical shows that these lie symmetrically with regard to the rest of the molecule. A graphic repre-

sentation of these relations is given by Van't Hoff in the figure.

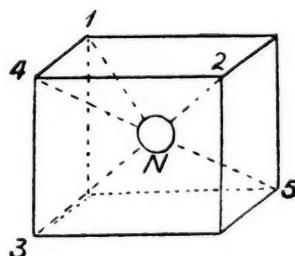


FIG. 13.

Here the nitrogen occupies the centre of the cube, and the five radicals connected with it occupy five of the corners. Of these, 1, 2, and 3, which have like positions, represent alkyls held by the three ordinary valences. When the nitrogen is triad these lie in one plane with the nitrogen atom; in the figure they are shown nearer to 4, as they would be attracted by the negative atom, say chlorine, occupying that position. The fourth positive group (alkyl) would occupy 5.

Now for the compound  $\text{NR'R''R'''Cl}$  a symmetrical arrangement is impossible. Four types are possible, as any one of the four radicals may occupy 5, and each type should be divisible into two isomers of opposite activity. Already several isomers have been prepared in the case of  $\text{N}(\text{C}_4\text{H}_9)_2 \cdot \text{C}_3\text{H}_7 \cdot \text{C}_2\text{H}_5 \cdot \text{CH}_3 \cdot \text{Cl}$ .

For  $\text{N}(\text{R}')_2 \text{R''R'''Cl}$  we may have either an asymmetric configuration ( $\text{R}'$  in 5) or a symmetric configuration ( $\text{R}''$  or  $\text{R'''}$  in 5), and the symmetrical being always the more favoured compound it is the latter only which exists; for Le Bel found it impossible to divide these compounds into active components.

For  $\text{NR}_3\text{R''Cl}$  two isomers are possible according as  $\text{R''}$  occupies 5 or 1 ( $1 = 2 = 3$ ). This is the isomerism just mentioned as occurring in the case of  $\text{N}(\text{CH}_3)_3 \cdot \text{C}_4\text{H}_9 \cdot \text{Cl}$ .

With regard to the literature of this subject, very full

references are given in Bischoff's *Handbuch*,<sup>1</sup> and in the work of Van't Hoff so often cited. In English there is an earlier edition of Van't Hoff translated by Marsh; and in the brief *Guide* to the subject by the present writer there is also an index to the literature.

Correction. On p. 502 the formation of active glyceric acid by means of *bacillus ethaceticus* was, in accordance with the reference given by Van't Hoff (*Atome im Raume*, p. 23), attributed to Tutton, instead of to Frankland and Trew (*Journ. Chem. Soc.*, lix., 96). The acid formed is right-handed; the salts, of which Tutton (*ibid.*, p. 233) examined one, being left-handed.

ARNOLD EILOART.

<sup>1</sup> Frankfurt-a-M., 1893-94. H. Bechhold.

## THE SUPRARENAL CAPSULES.

THE function of a gland which has a duct is a comparatively simple physiological problem, but the use of ductless glands has long been a puzzle to investigators. Recent research has, however, shown that most of, if not all, the ductless glands do form a secretion, and this "internal secretion," as it is termed, leaves the gland by the venous blood or lymph, and thus is distributed and ministers to the needs of parts of the body elsewhere. Many of the glands which possess ducts and form an external secretion, form an internal secretion as well.<sup>1</sup> Among these the liver, pancreas, and kidney must be mentioned. Among the ductless glands the thyroid has attracted considerable attention, because here important practical results in the treatment of the disease called myxedema have followed close on the heels of experimental investigation. More recently, however, the suprarenal capsule has excited interest; whether here also extracts of the gland will prove beneficial in cases of Addison's disease remains to be seen. There is already a small amount of clinical evidence in that direction,<sup>2</sup> but it is more in relation to the physiological aspects of the question that I desire, in this paper, to dwell.

In Dr. Rolleston's Goulstonian lectures on the suprarenal capsules delivered this year<sup>3</sup> there are as many as 187 references to original work on the subject; the literature is, therefore, far from scanty, but the main facts in the history of our physiological knowledge may be put in a comparatively short space. This I propose to do very briefly, and then proceed to give an account of the most recent researches in connection with the matter.

<sup>1</sup> The reader is referred for a succinct account of the present state of our knowledge on the general subject of internal secretions to Professor Schäfer's address to the British Medical Association, printed in the *British Medical Journal*, 10th August, 1895.

<sup>2</sup> See Dr. George Oliver, *British Medical Journal*, vol. ii., p. 653, 1895.

<sup>3</sup> *British Medical Journal*, vol. i., pp. 629, 687, 745, 1895.

The immense importance of the suprarenal bodies in nutrition was first indicated by Addison, who in 1855 pointed out that the symptoms of the disease now known by his name are associated with pathological alterations of these glands. This was tested experimentally by Brown-Séquard, who found a few years later<sup>1</sup> that removal of the suprarenals was rapidly and unfailingly fatal in all animals. The symptoms were practically the same (although much more acute) as those of Addison's disease, *viz.*, great muscular weakness, loss of vascular tone, and nervous prostration. These results attracted much attention, and numerous investigators set to work to verify them. Some failed to confirm Brown-Séquard's results, probably because the removal was incomplete, or accessory capsules existed. The controversy, however, soon ceased, and the subject was almost forgotten. The interest in the matter has now been revived, and Brown-Séquard's experiments have been repeated within the last few years by Brown-Séquard himself, Abelous and Langlois, Tizzoni, Schäfer, and many others. All these observations have tended to confirm the original statement of Brown-Séquard.<sup>2</sup> Abelous and Langlois found that the blood of animals dying in consequence of the operation is toxic for other animals which have been recently deprived of their capsules, though it causes no toxic results in normal animals. The symptoms caused by this blood are stated to be those of curare poisoning, that is, paralysis of the intramuscular nerve endings; they conclude that after removal of these glands a certain toxic product of muscular metabolism accumulates in the blood, and that the function of the glands is to remove or destroy this principle.

This is the "auto-intoxication" theory of the suprarenal capsules, and is similar to that which has been applied to the thyroid and other glands. It is chiefly founded on the fact that the blood of animals which are moribund in con-

<sup>1</sup> *Journ. de la physiol.*, t. i., 1858.

<sup>2</sup> Some few observers (*e.g.*, Pal, *Wiener klin. Woch.*, p. 899, 1894) have failed to produce death. Non-success was here, perhaps, due to the sources of failure already indicated.

sequence of the particular extirpation is poisonous, especially for other animals which have been submitted to the operation. It seems probable that the blood of an animal dying slowly from any disease would be toxic, and especially so to those animals whose resisting power has been lessened by a severe operation. Whether, however, the capsules do or do not perform an excretory function, they unquestionably produce a material which has entirely different properties from those stated to be possessed by the blood of animals deprived of these organs. This aspect of the question has been studied by making extracts of the healthy gland, and injecting these into the circulation and noting the results.

Pellacani,<sup>1</sup> both alone and in conjunction with Foa,<sup>2</sup> appears to have been the first to study the subject in this manner. The symptoms noted were chiefly respiratory, and death preceded by paralysis was in most cases the ultimate result. Marino-Zucco<sup>3</sup> attributed this result to neurine, which is contained in considerable amount in the capsules, and is stated to appear in the urine after the injection. None of these observers, however, availed themselves of the more exact methods of modern physiology, and give no graphic records illustrating their statements ; blood pressure they seem to have neglected altogether.

This gap has now been filled up by Schäfer and Oliver<sup>4</sup> in this country, and later by Szymonowicz<sup>5</sup> and N. Cybulski<sup>6</sup> in Poland.

Schäfer and Oliver confirm previous workers, in so far as they show that the effects are chiefly seen in the muscular system, but the toxic effects on the voluntary muscles are those of veratrine rather than of curare. The effect of

<sup>1</sup> *Arch. per le sci. med.*, iii., 1874.

<sup>2</sup> *Ibid.*, vii., 1884.

<sup>3</sup> *Chem. Centralbl.*, 1888. Marino-Zucco and Dutto, *Moleschott's Unters.*, xiv. Marino-Zucco and Guaruceri, *Chem. Centralbl.*, 1888, and *Arch. Ital. de Biol.*, x.

<sup>4</sup> " Proc. physiol. Soc." contained in *Journ. of Physiol.*, xvi., p. 1, and xvii., p. ix., and *Journ. of Physiol.*, xviii., p. 230.

<sup>5</sup> *Anz. der Akad. d. Wiss. in Krakau*, February, 1895.

<sup>6</sup> *Ibid.*, March, 1895; and *Gaze ta lekarska*, 1895, No. 12, Warschan.

injecting an extract of suprarenal capsules on involuntary muscle is equally marked. The enormous rise of blood pressure which immediately follows the injection is partly due to increase of the heart's force and frequency. This is best seen when the vagi are cut; if these nerves are intact, the heart is slowed; the increase of arterial pressure is, however, chiefly due to contraction of the arterioles, and this appears to be a direct action of the poison rather than an indirect one through the vaso-motor centre. These facts are supported by very beautiful tracings taken from the heart, from the arteries by the mercurial manometer, and from peripheral organs by the use of plethysmographic instruments. Many of these are reproduced in the paper last cited.

Szemonowicz and Cybulski confirm these facts in the main. The chief point of difference is that they consider the extract acts upon the vaso-motor centre, and not directly on the blood-vessels. In confirmation of this they state that the action is not obtained after section of the spinal cord. Schäfer and Oliver find on the other hand that section of the cord makes practically no difference. The most important new facts added by Cybulski are contained in the statements that the blood of the suprarenal vein contains the active principle of the gland in sufficient amount to produce physiological symptoms, and that the changes in the circulatory and respiratory systems accompanying deprivation of oxygen are no longer obtained in animals which have been deprived a few hours previously of their suprarenals; they also find that while arterial blood does not destroy the active principle, permanganate of potash does.<sup>1</sup> On this fact Cybulski finds a theory that it is got rid of in the body by oxidation. Professor Schäfer has carefully tested the statements in reference to asphyxia in three cases and been unable to arrive at the same results; the absence of asphyxial symptoms observed by Cybulski was probably the result of severe shock.

<sup>1</sup> Moore working in Schäfer's laboratory has found that oxidation of an active extract with hydrogen peroxide materially weakens its physiological effects.

The nature of the poisonous agent is still uncertain, but the interesting facts have been further made out that it is confined to the medulla of the glands, that it is absent from the suprarenals in cases of Addison's disease, and that the physiological effects are produced by doses compared to which those of homœopaths are gigantic. Schäfer estimates that one-millionth of a gramme per kilogramme of body weight is sufficient to produce physiological effects. The effect is transitory, the poison apparently being packed away and rendered innocuous in certain organs which cannot at present be satisfactorily specified.

It should be added that the extracts of the glands used were prepared with water, with alcohol of various strengths, and with glycerine. They are made either from the fresh or dried gland, or by boiling for a few minutes. The principle is not soluble in absolute alcohol or ether. The animals experimented on were chiefly dogs, but cats, rabbits, guinea-pigs, and a monkey gave confirmatory results.

As a general conclusion, Professor Schäfer inclines to the theory of internal secretion as against that of auto-intoxication; the gland forms something which is distributed to the muscles, and is essential for their normal tone; when the gland is removed the toxic effects seen are the result of the absence of this internal secretion.

Although, as just stated, the chemical nature of this remarkable substance is still uncertain, there have been some researches directed to determining what it is. B. Moore<sup>1</sup> considers that it is identical with a powerful reducing substance found only in the medulla of the gland, and first described by Vulpian.<sup>2</sup> At any rate the solubilities of this reducing material are identical with those of the active physiological principle. It gives a dark green or blue colour with ferric chloride passing through purple to a dark red on the addition of ammonia or sodium carbonate. With chlorine, bromine, or iodine water, peroxide of hydrogen or alkalis in the presence of oxygen, it gives a rose-red

<sup>1</sup> "Proceedings of Physiological Society," p. xiv., 1895 (contained in vol. xvii., *Journal of Physiology*).

<sup>2</sup> *Compt. Rend.*, xliii. and xlvi.

coloration discharged by sulphide of hydrogen or of ammonium. It is insoluble in organic solvents like alcohol, ether, or benzene; it is soluble in water, alcohol *plus* water, and dilute acids. It is found only in the medulla of the suprarenal capsule, or after death in the blood of the suprarenal vein. Its presence in physiologically active extracts is constant; when absent the extracts give a negative physiological result.

Moore did not succeed in separating or identifying it. It was not attacked by acids, or by boiling for a few minutes, but it is destroyed by alkalis, by oxidising agents, and by prolonged boiling. It is not precipitated by alcohol, saturation with ammonium sulphate, by mercuric chloride, potassio-mercuric iodide or tannic acid. It does not reduce Fehling's solution even after boiling with mineral acids nor does it form a crystalline compound with phenylhydrazine. It is not volatile either alone or with aqueous vapour. It dialyses freely through parchment paper, and the highly active dialysate is free from proteid. It is not affected by gastric digestion.

From these characters, largely negative, one can say what the substance is not, though one cannot say what it is. It is certainly not a proteid. An investigation of the proteids of the gland shows that they are of the globulin and nucleo-proteid variety; in fact like the proteids of other cellular organs (D. N. Nabarro).<sup>1</sup> It is certainly not a carbohydrate, or a fat, or an alkaloid. This excludes neurine and its related alkaloid choline.

The only other research bearing on the question that I can find is by Paul Manasse.<sup>2</sup> He states that it has long been known that the medullary substance of the suprarenal capsules contains a material which becomes dark brown with salts of chromic acid, unless the capsules have been previously hardened in alcohol. The substance is soluble in alcohol, and shows great similarities to the body named

<sup>1</sup> *Proc. physiol. Soc.*, p. xvii., 1895.

<sup>2</sup> Schäfer (*ibid.*, p. iii., 1894, contained in *Journ. of Physiol.*, vol. xvi.) finds that the physiological action of these alkaloids is quite different from that of suprarenal extracts.

<sup>3</sup> *Zeit. f. physiol. Chem.*, vol. xx., 478, 1895.

jecorin, first separated by Drechsel<sup>1</sup> from the liver. The actual method of isolation is too technical to be given here, but Manasse used practically the same process with the suprarenal. Baldi<sup>2</sup> has also separated jecorin not only from the liver but from the spleen, which next to the liver gives the highest yield, brain, and muscle. Jecorin resembles lecithin in many of its properties and seems to accompany lecithin pretty constantly (Baldi). The resemblance to lecithin noted by Drechsel is accentuated by the fact discovered by Manasse, that it yields choline, glycero-phosphoric acid, and fatty acids on decomposition. The carbohydrate obtainable from it, and to which it owes its reducing properties, appears by its characters to be most like dextrose. The power which jecorin possesses of reducing Fehling's solution seems to vary with the source from which it is derived (Baldi).

The substance obtained from the suprarenals, however, is not jecorin, though it has a general resemblance to it. The two bodies differ in some of their solubilities, and in the fact that the new substance does not reduce Fehling's solution until after prolonged boiling with sulphuric acid; the sugar then formed appears to be dextrose. If one next compares the percentage composition of the two substances the difference is seen to be very marked, especially in the amount of carbon, nitrogen, and phosphorus. This is shown in the following table.

	Jecorin.		Substance from suprarenals.
	Drechsel.	Baldi.	Manasse.
C	51.32-51.64	46.88-46.89	41.43
H	8.11- 8.25	7.81- 8.09	7.16
N	2.86	4.36- 4.88	0.3
S	1.42- 1.47	2.14- 2.70	1.8
P	2.2 - 3.7	2.29- 2.75	4.44
Na	2.72	5.72	—
O	30.10	—	—

<sup>1</sup> *Journ. prakt. Chem.*, xxxiii., 425.

<sup>2</sup> *Du Bois-Reymond's Archiv*, 1887, Suppl. No., p. 100.

Manasse's research appears to have been undertaken without any special reference to the question of the physiological action of the suprarenal capsules, or of the work of Schäfer and his colleagues. But it is by no means uninteresting to inquire whether his investigation does not after all give the key to the problem. Here is a substance, of a reducing nature, resembling jecorin it is true in some points, but practically unique, and confined to the medulla of the suprarenal capsules. It is soluble in alcohol, and Moore's substance is not; but the addition of a little water to the alcohol renders Moore's substance soluble. It is possible to explain this difference therefore by variations in the strength of the alcohol used. Another distinction between Manasse's and Moore's substance is that the former reduces Fehling's solution after *prolonged* treatment with sulphuric acid, whereas the latter does not. Perhaps this difference may be explained by different interpretations of the word prolonged. At any rate the matter appears promising, and all will watch with interest further developments of this remarkable series of investigations.

W. D. HALLIBURTON.

## THE CLASSIFICATION OF IGNEOUS ROCKS.

THERE is perhaps no branch of study in which the accumulation of material has so far outrun the advance of systematic science as in Petrology, and to the zeal thus shown on the purely descriptive side of the subject may be attributed in some measure the confusion so apparent in the classification and nomenclature of the igneous rocks. There are, however, in the nature of the subject itself, considerations which seem to make classification a matter of peculiar difficulty. Petrology knows no species or genera. The laws of precision, chemical and crystallographic, which give individuality to minerals, and lead to the grouping together of allied minerals, afford us no help in dealing with complex mineral aggregates such as igneous rocks. Neighbouring rock-types, and even widely diverse types, are linked together by an indefinite series of intermediate varieties, and are found in the field to graduate into one another by insensible transitions. Of any such fundamental principle as that of descent, which defines species and underlies classification in the organic world, petrologists have obtained as yet only a dim glimpse. It is perhaps in this direction that the solution of the problem is to be sought, but a clear conception of all the physical and chemical principles involved in the genesis of rocks from molten silicate-magmas is a necessary preliminary which is at present far from being realised. Meanwhile, it may be of interest to recall some of the steps by which the present position of the question has been reached.

To trace completely the growth of opinion with regard to the classification of rocks would be to write a history of Petrology. Moreover, the earlier writings on the subject, though full of interest historically, scarcely touch the science as now understood, and therefore need not engage our attention. Instead of following a chronological sequence it will be more instructive to consider briefly the several points of view of those who have approached the subject

from different sides, and we will therefore notice in turn the different factors which, from time to time, have been made to enter into schemes of rock-classification. The development of these schemes shows a progress from a purely artificial towards a natural system, the latter being, however, a goal sought rather than an end attained. The earlier workers seem to have held no conception of a natural system of classification, even as an object to be aimed at. Their view is perhaps not unfairly represented by the opening sentence of Pinkerton's preface in 1803 : "Le seul avantage qui résulte de tout système méthodique en histoire naturelle, est de soulager la mémoire".<sup>1</sup>

The first factor that we shall notice in the various schemes of classification of igneous rocks is *geological age*. The rival systems in the early part of this century were often referred to as the "geological" and the "mineralogical". They were to some extent identified with Plutonism and Neptunism, but the two principles in rock-classification may be traced back to an earlier date. Linnæus, Wallerius, and others of the Swedish school in the middle of the last century, embraced the rock-types known to them in their mineralogical systems of the inorganic kingdom ; but they had also concluded, from observations in their own country, that the several broad divisions of rocks occupied each its own definite position in the crust of the earth. In other words, they recognised a stratigraphical succession of rocks, which they believed to be of general application. This idea is more familiarly associated with the name of Werner, who elaborated it into a system based on his researches in the mountains of Saxony. In these early speculations, which were indeed the beginning of stratigraphical geology, the important conception of an ordered succession of rocks was pushed so far as to obscure the distinction between truly bedded sediments and igneous rock-masses ; while, further, the succession observed in a single area was assumed to hold good universally. Werner's scheme of

<sup>1</sup> I have met with this earlier work of Pinkerton only in the French translation, *Esquisse d'une nouvelle classification de minéralogie*.

classification has at the present day no more than a historic interest; perhaps the best expositions of it are contained in the writings of some of the Scottish geologists, Jameson, MacCulloch, etc.

There are, however, certain relics of Wernerism still extant, two of which may be mentioned in passing. One is the theory, still held in various forms, that most of the crystalline schists and gneisses have been formed at a period of remote geological antiquity, and no similar rocks have been produced since the date of the "Urgneiss" or "Grundgebirge". The other is the doctrine of an essential distinction between the "older" and "younger" igneous rocks, on which some remarks have been made in an earlier paper in this journal.<sup>1</sup>

Apart from these ideas, which appear somewhat crude and arbitrary in the light of modern researches, various attempts have been made to incorporate the chronological principle in one form or another in classifications of igneous rocks based on wider generalisations. It has long been recognised that eruptions, whether deep-seated or superficial, have not been equally distributed over the geological time-scale. It is indeed the long pause in igneous activity in Mesozoic times that has lent colour to the doctrine of an older and a younger series of rocks already alluded to, and closer examination reveals the existence of at least three or four maxima of activity during the ages contemplated by stratigraphical geology. The correspondence, as regards both time and space, of igneous activity with the great crust-movements that have shaped the continental masses, and determined the dominant mountain ranges, is a subject upon which we cannot enlarge here, but some have thought to find in this a philosophical starting-point for a genetic grouping of igneous rocks. The recurrence of identical types at widely separated epochs, however, forbids the idea of a systematic classification on such a basis. If, to fix our conception, we imagine with Bertrand (24) that all the rocks belonging to any one period of crust-movement and

<sup>1</sup> "SCIENCE PROGRESS," vol. ii., pp. 48-63, 1894.

igneous activity have been derived by processes of differentiation from one great subterranean magma-basin, we must admit that these processes have completely masked any original differences that may have subsisted between one parent magma and another.

There is another point of view from which the chronological sequence of igneous rocks may conceivably become an element in a natural classification, *viz.*, with regard to the order of eruption of different rock-types belonging to one period of activity, and within a given region. One of the first geologists to address himself to this question was Richthofen (6), whose "Natural System of Volcanic Rocks," worked out chiefly in the Western States of America and in Hungary, has been given a wide application. The rocks considered by the author were those of the Tertiary epoch, as developed in what he has styled "massive" eruptions. He divided them into five orders—propylites, andesites, trachytes, rhyolites, and basalts—each subdivided into families, and he laid down as a universal law that these several orders have been erupted in regular sequence as named. More extended knowledge has only partially confirmed this generalisation of Richthofen as regards the succession of the Tertiary lavas; nor do the rocks of other periods—*e.g.*, those of the Hercynian eruptions in Central Europe—appear to conform to any such simple law. The law that the extravasation of material of intermediate composition has normally preceded the appearance of either acid or basic lavas seems to be borne out in a large number of instances, and such a law connects itself simply with speculations on the differentiation of rock-magmas. But any classification built upon such considerations as this would evidently be founded upon genetic principles, the factor of relative age not being really an essential one.

We pass on to consider the classifications based upon descriptive characters, the foremost being, of course, *mineralogical constitution*. This being a necessary element in the description of rocks has naturally come to figure prominently in the definition and classification of rock-types, and has often been assigned the first place. The earlier writers

who adopted this view, whether separating composite rocks from simple minerals or not, were content, for the most part, to group the rocks in accordance with the dominant mineral of each. At that time there were, however, formidable obstacles in the way of any mineralogical classification of rocks. In the first place, the minerals themselves were very imperfectly known, and their mutual relations scarcely understood at all. A grouping of minerals according to their "external characters" could not lead to a rational classification of rocks upon a mineralogical basis. This difficulty naturally disappeared with the advance of mineralogy, especially with the importance attached by Haüy and his school to crystallography, and the chemical investigations of Berzelius and others. A more serious obstacle, in what we may term the pre-microscopic days of Petrology, was that the fine-textured aggregates and the compact ground-mass of many porphyritic rocks defied mineralogical analysis. The writers who, in the earlier decades of this century, advocated a mineralogical as opposed to the so-called geological system of classification, were accustomed to divide all rocks into homogeneous and heterogeneous, including under the former head such substances as felsite ("compact felspar") and basalt, which were not resolved by the methods then in use. Cordier's demonstration, in 1815, of the composite nature of the compact ground-mass sufficed to shake but not to destroy this distinction. Thus we find Brongniart, twelve years later, subdividing his "homogeneous" rocks into two orders—"phanérogènes" and "adélogènes"; the former being simple rocks consisting in each case of one known mineral; the latter being formed "wholly or in part by a mechanical union of mineral particles," which he makes no attempt to specify. Such rocks as basalt are included in this latter order, while even in the former we find, *e.g.*, lherzolite under the head of pyroxene.

The microscope has now almost completely removed the difficulties felt by the earlier petrologists, although the ground-mass of many acid rocks—the "petrosilex" which baffled Cordier—has furnished material for controversy down

to a very recent date. Microscopic investigation has also detected the important part played in various rocks by such minerals as nepheline, melilite, and the rhombic pyroxenes. With the more complete knowledge of the actual mineralogical constitution of igneous rocks thus gained, a comprehensive classification on this basis became for the first time possible, and this is accordingly a prominent element in most current systems. The application of such systems to the great variety of rocks now described and studied has, however, brought out other difficulties, which are evidently inherent in the method.

The choice of characteristic minerals has been determined, in the first place, by the important *rôle* filled by the felspar group in the great majority of igneous rocks; and, in the hands of Roth, Zirkel, Rosenbusch, and their followers, the dominant kind of felspar in a rock has come to be a prime factor in fixing its classificatory position. Here the need of some ready practical method of discriminating the several felspars has presented an obstacle which is only gradually being surmounted. The presence in some rocks of free silica in addition to acid felspars and the poverty or absence of any felspathic constituent in other rocks have been used to mark further divisions, while the coming in of the "felspathoid" minerals, leucite and nepheline, affords another character of the same rank. Excepting perhaps olivine, the ferromagnesian minerals have been reserved to mark subdivisions of a lower order.

With whatever degree of success such a scheme may represent the true relationships of rocks of granitoid structure, it can be applied only in a modified form, and not without caution, to the porphyritic types. This point has been emphasised by Michel Lévy (23) in an elaborate critique of the second edition of Rosenbusch's *Manual*. He maintains the propriety of taking as a starting-point in mineralogical classification the dominant "white element" (felspar or felspathoid) of the second period of consolidation of the rock, rather than the larger and more prominent crystals of the first period, which often make up but a small proportion of the total bulk. He claims to show that the

grouping arrived at by Rosenbusch is, in many respects, arbitrary, and fails to present a proper correspondence between the families of the porphyritic and the granitoid rocks; while the classification proposed by Fouqué and himself in 1879, which he reproduces with little modification, is much truer to nature (15). It may be remarked that the petrologists of the French school have endeavoured more systematically than the Germans to carry out the distinctions based on the different kinds of felspar, as, for example, in the separation which they make between andesites and labradorites, the one characterised by andesine, the other by labrador felspar. The common use by German and English petrographers of the name "plagioclase," covering such widely different minerals as albite and anorthite, has probably done much to retard the recognition of essential differences among rocks thus loosely thrown together; and we may endorse the hope expressed by Becke and Michel Lévy that methods of increased precision may drive this vague term out of geological literature. Meanwhile, the division into alkali-felspars and soda-lime-felspars, with such subdivision of the latter as is practicable, must be preferred to the distinction founded on crystallographic characters.

The classifications of igneous rocks in current use take account not only of the constituent minerals but of their mutual relations, *i.e.*, of the *structural characters* of the rocks. An arrangement constructed on this two-fold basis may indeed claim to give some approach to a natural system founded on genetic principles; since the mineralogical constitution of a rock represents in some degree the nature of the parent magma, while the structure affords some index of the conditions of consolidation. In the older systems structural features of comparatively trivial importance were often elevated to a prominent rank, and no distinction was observed between original and secondary characters; so that, for instance, spherulitic and amygdaloidal structures might be included together under the head of "variolite". Even in some modern text-books a strict fidelity to purely descriptive characters sometimes leads to anomalies from the genetic point of view.

Rosenbusch (16) has adopted an important distinction between the even-grained (*körnig*) structure, in which each constituent mineral belongs to a single stage in the consolidation, and the porphyritic, in which there is a recurrence of one or more minerals in a second generation, so that the constituents belong to two periods, the "intra-telluric" and the "effusive". The two types of structure are typically exemplified in the plutonic and the volcanic rocks respectively. On this point the German and French schools are at variance, the latter claiming to recognise two distinct periods of consolidation in almost all igneous rocks,<sup>1</sup> but on examination the difference seems to be one of theoretical rather than practical importance. A more real difference of opinion exists as to the propriety of establishing an intermediate division between the plutonic and the volcanic types of structure. Such a division is roughly represented by the "dyke-rocks" of Rosenbusch (22, 36), who, however, does not carry out the principle systematically. The difficulty arises chiefly with reference to the basic rocks, the strong tendency to crystallisation of magmas poor in silica rendering the structural and textural characters in their case of less significance than in the more acid rocks. Brögger (35) has insisted upon the necessity of a division intermediate between the plutonic and the volcanic, which he terms "hypabyssal," the distinction being based practically upon structural characters; while Roth, Zirkel, and Lossen, as well as the French writers, have considered such a division superfluous and ill defined.

It is manifest that, if we are to work towards a true natural classification, we must have regard in the first place to characters which are original and essential. This brings us to another question on which unanimity has not yet been attained. Allport, Bonney, Rutley, and other English petrologists have long maintained that many fine-textured rocks, especially among those of acid composition, owe their present structure to the secondary devitrification of a mass

<sup>1</sup> For further criticism of Rosenbusch's views on this point see Zirkel (34), and especially Cross, *Fourteenth Ann. Rep. U.S. Geol. Surv.*, p. 233, 1895.

originally vitreous. Whether this idea has in some cases been pushed too far is a point that might be argued, but it is certain that the Continental workers as a body have not yet fully appreciated its importance. The extent to which such secondary changes may obscure the true nature of the rocks is well illustrated by the ancient lavas of the Eastern States of America. Recent papers, published in that country, have fully recognised the importance of devitrification and other transformations, and the altered rocks have been designated by such terms as aporhyolite, apodacite, etc., to mark at once their initial characters and the fact of their subsequent alteration.

There is a sense in which the *geological relations* or mode of occurrence of a rock may enter into petrological classification. On the one hand, as marking the conditions under which consolidation took place, the mode of occurrence is connected with genetic considerations; on the other hand it is in close relation with the structure and texture of the rock, as indeed is implied in the use of such terms as "plutonic" and "volcanic" to denote divisions of rocks which are really defined by structural characters.

We ought next to consider to what extent the *chemical composition* of igneous rocks may enter, directly or indirectly, into their systematic arrangement. It is clear that if we are at liberty to regard each rock as representing the result of consolidation of a given molten magma, the composition of that magma may be proposed with considerable cogency as a prime factor in petrological classification. The empirical laws which seem to hold with a high degree of generality in the chemical analyses of igneous rocks, pave the way for such a system. The percentages of the several oxides are found to vary within more or less defined limits, and their variations are in great measure correlated, so that with an increase in the amount of silica we find generally an increase in certain other oxides and a diminution in others. Thus a large proportion of igneous rocks fall roughly into a linear series, having at the "acid" end types rich in silica and alkalies, at the "basic" end others rich in magnesia and iron-oxides. The laws here roughly expressed, and subject

to important exceptions, presumably result from fundamental principles upon which we can at present only speculate ; but it seems safe to assert that they will be embodied in any natural system of classification which may ultimately be arrived at.

Since we cannot have a chemical analysis of every rock it is clear that the practical application of a chemical classification must be in general an indirect process. The object kept in view must be to construct such a system, based on mineralogical characters, as shall most closely correspond with the chemical grouping taken as a guide. The relatively small number of the common rock-forming minerals—a consequence of the chemical laws already alluded to—facilitates such a scheme, but there are obvious considerations which limit its application. In the first place the mineralogical analysis of a rock is necessarily a qualitative rather than a quantitative one. This difficulty is only very partially evaded by ranking some mineral constituents as "essential" and others as "accessory," or by trying roughly to take account of the relative proportions of the essential minerals in a rock. The implied discrepancy, however, between a rough mineralogical and an accurate chemical analysis is perhaps smaller than it appears. It may even be argued that, where the two estimates differ, a mineralogical is not less likely than a chemical characterisation to lead to a true interpretation of relationships, for in cases where the relative proportions of the minerals vary widely (*e.g.*, in gabbros) we often find the extreme types forming parts of one and the same body of rock.

A more difficult question arises in the case of the volcanic rocks, most of which contain more or less unindividuated glassy matter. A mineralogical description, however complete, cannot express the chemical composition of a rock which consists only partly of minerals. It may be said that the minerals which are actually found give an indication of the composition of the magma from which they have crystallised out ; but, granting this, can we safely assume that that magma had the same composition as the rock finally consolidated ? The case has been well put by Judd

(26) in a paper dealing with the volcanic ejectamenta of Krakatoa. These belong to the hypersthene-andesite group, and are comparable with the ancient and modern lavas of Santorin, the rock of Buffalo Peaks in Colorado, and the freshest of the Cheviot lavas. All these consist of the same minerals in roughly the same relative proportions, with residual glass of approximately the same composition in all. Nevertheless these rocks range in total chemical composition from an acid type with 70 per cent. of silica to a basic type with 52 per cent. This variation is connected with the relative proportion of the acid glass to the total minerals (on the whole basic), this proportion being 9 : 1 and 1 : 9 in the extreme types mentioned. In the author's opinion these and other facts point to the conclusion that "after the partial separation of a magma into crystals and a colloid residue, the two may be separated by a process of liquation, and subsequently be mingled again in varying proportions". In a later paper on the intermediate lavas of the Western Islands of Scotland the same writer applies this idea to the associated rocks belonging to one volcanic centre, that of Ardnamurchan, and expresses the opinion that "there is no direct and necessary relation between the porphyritic crystals of a volcanic rock and the magma by which they are enveloped". Without endorsing the rather extreme conclusion we may note that we have in this suggestion a method of differentiation in rock-magmas demanding only mechanical means, and possibly capable of producing important results.

Apart from the question just raised, if we know the component minerals of a holocrystalline rock, and approximately the relative proportions in which they are present, we have a sufficient index of the place of the rock in any scheme founded upon total chemical composition. It is interesting to note that the converse does not hold; a bulk-analysis of a rock would not always enable us to predict its mineralogical constitution. For example, Iddings (33) has pointed out that some of the lamprophyres are identical in chemical composition with certain leucite-bearing and other lavas, although the two sets of rocks differ widely as regards

their constituent minerals. A difference, though smaller in degree, is noticeable in the mineralogical constitution of many plutonic rocks and the minor intrusions belonging to them. In other words, the minerals developed by the crystallisation of a given magma depend not only on the composition of the magma, but also on the conditions attending its consolidation. A classification founded primarily on chemical principles, therefore, will sometimes bring together rocks which in a mineralogical scheme would be separated. We may note in passing one conclusion to be drawn from such facts as those cited by Iddings—though it is not the conclusion drawn by that author—namely, the necessity of a “hypabyssal” division of rocks to receive such types as the lamprophyres.

A complete chemical grouping of igneous rocks would probably take account of the proportions, firstly of silica; secondly of the alkalies with reference to the silica, and of soda relatively to potash; thirdly of lime, magnesia, and the iron-oxides, relatively to one another. Having regard to these points, it would be possible to construct a system which would for the most part agree with a mineralogical one. Where the two differed, the chemical system would more accurately represent fundamental relationships of the rocks, regarded as consolidated rock-magmas.

Adopting the point of view just indicated, *viz.*, that the total chemical composition of an igneous rock is the prime datum, we may inquire what other character or circumstance is to be taken as a supplementary factor in such a scheme of classification. And we are led logically to the conclusion that the only remaining “independent variable” is the *ensemble* of conditions governing the consolidation of the magma supposed given, or in other words the geological environment, which is now represented for us by the mode of occurrence and geological relations of the rock. We have seen that this may influence, not only the structural and textural characters, but also the mineralogical constitution of a rock of given composition. The abyssal, hypabyssal, and superficial (volcanic) conditions afford a three-fold division, which is doubtless susceptible of further

refinement. These, and subdivisions of them, while sufficing for rough purposes, cannot, however, adequately represent the complex conditions through which many igneous rocks have passed during what we may describe as a varied life-history. The record preserved in the rocks themselves often gives evidence of successive stages of consolidation under different conditions, of minerals crystallised out at one stage and partially or wholly resorbed at another, and of other changes of circumstances, either gradual or abrupt.

The assumption that the total chemical composition of a partially fluid mass has remained constant through such vicissitudes as are thus indicated, becomes on reflection a very improbable one. Nor can we set aside the numerous cases adduced in late years to prove that chemical, as well as mineralogical differentiation has been brought about under suitable conditions in originally homogeneous rock-mmagmas. As regards the nature of these conditions, and the mode of operation of the differentiating processes, almost everything is still to be learnt ; but the facts seem to justify the belief that the bulk-analysis of an igneous rock, as well as its mineralogical and structural characters, may often be dependent in greater or less degree upon the conditions governing its consolidation, the circumstances attending its eruption, and other facts in its history. Light will be thrown upon the subject both by the study of individual rocks and by the comparison of groups of associated rocks to which we are warranted in attributing a community of origin.

The idea of relationship or "consanguinity" among igneous rocks, pointing to some kind of common origin, brings us to contemplate the possibility of a classification based on *genetic* considerations. This, as already remarked, can at present be regarded as only a distant goal, and to follow up the subject would lead us into untrodden paths. We shall content ourselves with noticing the work of Brögger (35), who has made a bold attempt to apply the principles of differentiation to a systematic arrangement of the numerous peculiar rock-types of the Christiania basin.

Rosenbusch (22), perhaps for convenience of descriptive treatment rather than as a strictly logical arrangement, divides the igneous rocks in the first place into three classes according to their mode of occurrence, a factor with which the micro-structure of the rocks is closely connected. These three classes, "Tiefengesteine," "Ganggesteine," and "Ergussgesteine," are then divided into families defined by mineralogical (and to some extent implicitly by chemical) characters. It is noticeable that while there is a fair correspondence between the families of the first and third classes, the "Ganggesteine" or "dyke-rocks" include some, such as the aplites and the lamprophyres, which are not easily paralleled among either the plutonic or the volcanic rocks.

Brögger, on the other hand, takes as his primary divisions families defined by chemical characters. These families may be divided into subfamilies, also on chemical grounds, and each includes abyssal, hypabyssal, and superficial rocks. The granite family, for example, embraces all igneous rocks having the composition of the granites; such as normal granites, granite-porphries, granophyres, quartz-porphries, pitchstones, rhyolites, etc. But it also finds places for rocks which, while having close relations with these, differ from them in chemical, as well as in mineralogical and structural characters. The hypabyssal members and marginal modifications (*Grenzfaciesbildungen*) fall indeed under two heads; non-differentiated ("aschiste") and differentiated ("diaschiste"). Under the former head are placed the quartz-porphries, granophyres, etc., while the latter covers such rocks as minettes and aplites.

An important feature of Brögger's system is the conception of a *rock series*. In a tabular scheme the various types are ranged in rows and columns, the rows corresponding to families, and the columns to series. The members of one series thus belong to different families. The ideal rock series consists of a number of such types, connected by intermediate gradations, and falling under the same broad structural division (plutonic, hypabyssal, or volcanic). They have certain mineralogical and chemical characters in

common, while in other characters they present a continuous variation from one end of the series to the other. One such series, comprising the types grorudite, sölvsbergite, and tinguaite, is described in detail in the first instalment of the author's "Eruptivgesteine des Kristianiagebietes". These are hypabyssal rocks occurring as dykes. They have in common the constantly low percentages of lime and magnesia, the preponderance of soda over potash, etc.; while the proportions of other constituents vary considerably, though in a regular manner, the percentage of silica falling from seventy-four to fifty-six, that of alumina rising from eight to twenty, and that of the alkalies jointly from eight to sixteen.

The types just mentioned belong to different families, which are also represented in the district both by plutonic and by other hypabyssal series. Thus the grorudite belongs to the family (or rather subfamily) of soda-granite. It agrees with this plutonic rock somewhat closely in chemical composition, but is rather richer in ferric oxide and alumina. It is therefore to be referred to the "diachist," but does not imply an extreme differentiation as compared with the soda-granite. Sölvsbergite bears a like relation to the quartz-syenite of the district (nordmarkite), and tinguaite to the nepheline-syenite (laurdalite). The three dyke-rocks thus seem to have had similar histories and to play corresponding parts in the great group of associated igneous rocks of the district. Another series includes the rhomb-porphries, some of which are well-known rocks. These have special characters in common, such as the peculiar crystallographic habit of the felspar crystals, which distinguishes them at once from the other hypabyssal series; but they embrace a considerable range of types belonging to different families. The plagioclase-rhomb-porphyry corresponds to the plutonic gabbro-diabase, the ordinary type to the augite-syenite (laurvikite), the nepheline-bearing type to the laurdalite, and the quartz-bearing to the nordmarkite.

Contrasted with the idea of a rock series is what the Norwegian geologist terms a "Faciessuite," comprising a

graduated succession of types which may form parts of a single body of eruptive rock, such as a laccolite. The variations, chemical, mineralogical, and structural, in such a suite are the result of differentiation *in the laccolite itself*; while the differences between the several members of a series are due to "*tiefmagmatische*" differentiation, effected in the parent magma-basin prior to the intrusion.

In the case of such an assemblage of igneous rocks as those of the Christiania district, with so strongly marked consanguinity, it can scarcely be doubted that all have originated, by differentiation of more than one order, from a common stock. If similar rocks in other regions have had a like origin, a complete knowledge of the mutual relations of the rocks should lead to a natural classification founded on fixed genetic principles.

The condition here expressed seems to be a necessary one. It is, of course, no objection to such a system as is here contemplated that it brings under one family rocks which differ widely in composition as well as in characters; but if one rock-type may figure under two or more families, the system seems to be lacking in simplicity. Brögger has remarked, for example, how bostonite and camptonite may arise as complementary products of differentiation of either a gabbro- or a nepheline-syenite-magma; so that, in a genetic grouping of general application, the camptonites of Norway and of New England would fall into two widely separated families. If the facts have been rightly interpreted, such anomalies must be inseparable from a general classification founded on genetic relationships. In any case, such work as Brögger's, involving minute comparison of many associated rock-types with reference to their mode of origin, cannot fail to throw light upon the problem of a natural classification.

In the foregoing pages no idea has been given of the details of the various classificatory schemes advocated by different petrologists. This can be obtained from the works cited below. They are selected from a rather voluminous literature to represent the different ways in which the subject has been approached, and in some measure the develop-

ment of opinion since chemical and microscopical researches have afforded data for attempts in the direction of a natural system.

No allusion has been made above to the question of the *nomenclature* of rocks. This is to some extent affected by the difficulties which beset the problem of rock-classification, and indeed many of the names now in use are little better than "Sacknamen," as Brögger has expressively described them. Names covering groups and families of rocks cannot become fixed until the groups and families themselves have been accurately defined, and their limits have become a matter of common agreement. Much confusion has been gratuitously introduced by the practice of arbitrarily extending, restricting, or changing the meaning of classificatory or descriptive names. Some, like syenite and granophyre, are used in a sense which contradicts their etymology; others, like pyroxenite, are applied by different writers to totally different groups of rocks. One fruitful source of confusion is the extension to a family of rocks of a name, such as foyaite or tonalite, belonging originally to a single type.

Names of rock-types must clearly be numerous, and increasingly so. To this there can be no objection, provided the names are strictly reserved for rocks of the types in question, and provided a new name is given to a new type of rock only when the latter has been fully described. The names least likely to cause difficulty in the future are those derived from the localities of the typical rocks, and thus embodying information which is independent of any theory. To take the type rock from one locality and the name from another, as in the monchiquite of Hunter and Rosenbusch, is a proceeding to be deprecated. If ever a satisfactory classification is arrived at, it will not be difficult to embody it in a new nomenclature, possibly a binomial or trinomial system as suggested by Wadsworth (17); but any such systematic terminology presupposes a knowledge of the true relationships of igneous rocks which is still a desideratum.

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- the number of mineral constituents regarded as essential; thus there are unitary, binary, and ternary rocks.]
- (8) VOGELSANG, H. Ueber die Systematik der Gesteinslehre und die Eintheilung der gemengten Silikatgesteine. *Zeits. Deuts. Geol. Ges.*, vol. xxiv., pp. 507-544, 1872. [The primary division into six "types" is based on the constituent minerals, which are distinguished as of four ranks of different importance; subdivisions are based on structure, and especially on the absence or presence of the porphyritic character. While showing in his preliminary remarks that the distinction of older and younger is logically untenable, the author retains it in his tabular scheme.]
- (9) LASAULX, A. VON. *Grundzüge einer neuen Systematik der Gesteine*. 8vo, 11 pp. Bonn, 1872. [Founded on (i.) structural and (ii.) mineralogical characters. Under the composite crystalline rocks the main division is between porphyritic and non-porphyritic. A brief review of the subject is prefixed to the table.]
- (10) CREDNER, HERM. *Vorschläge zu einer neuen Classification der Gesteine*. 8vo, 12 pp. Leipzig, 1873. [With several departures from the Naumann-Zirkel arrangement adopted in the author's *Elemente der Geologie*. The age-criterion is here abandoned.]
- (11) SZABO, JOSEF. *Trachyte eingetheilt nach dem natürlichen System*. 8vo, 9 pp. Vienna, 1873. [An example of a mineralogical grouping applied to the Tertiary lavas, the author's "trachyte" including all these with the exception of the olivine-bearing types. They are divided into "quartz-trachytes" and "trachytes," and in each division are eight groups based on the dominant species of felspar.]
- (12) LASAULX, A. VON. *Elemente der Petrographie*. 8vo. Bonn, 1875. [An example of a classification grounded on structural and textural characters.]
- (13) ROSENBUSCH, H. *Mikroskopische Physiographie der Massigen Gesteine*. 8vo. Stuttgart, 1877. [The main divisions are based on the predominance of orthoclase, plagioclase, nepheline, and leucite respectively; the subdivisions on the association with these minerals of mica, augite, hornblende, and enstatite. The peridotite group is here first introduced.]
- (14) DANA, J. D. On some points in Lithology. *Amer. Journ. Sci.* (3), vol. xvi., pp. 336, 431, 1878. Partly reproduced in *Geol. Mag.*, pp. 222-225, 1879, with a criticism by T. G. Bonney, pp. 199-203. [A loose mineralogical scheme in which the genetic principle is wholly set aside.]

- (15) FOUQUÉ, F., and LÉVY, A. MICHEL. *Minéralogie Micrographique: roches éruptives françaises*. 4to. Paris, 1879. [The grouping takes account of geological age, mineralogical constitution, and structure. Under the second head the divisions are based on the dominant felspathic or felspathoid constituent and subdivisions on the chief ferro-magnesian element. Under structure the broad divisions are the granitoid and the trachytoid. Most French writers have followed this arrangement.]
- (16) ROSENBUSCH, H. Ueber das Wesen der körnigen und porphyrischen Structur bei Massengesteinen. *Neu. Jahrb. für Min.*, vol. ii., pp. 1-16, 1882; with table. [The structure (even-grained, porphyritic, or glassy) is used as a factor in the classification, in conjunction with the dominant felspathic and ferro-magnesian minerals.]
- (17) WADSWORTH, M. E. Lithological Studies. *Mem. Mus. Compar. Zool. Harvard*, vol. xi., part i., 1884. [The author's ideal "natural" classification is one "which will place together those forms nearest allied in their general characters, composition, structure, and origin, when the rock as a whole is considered and not certain of its characters only".]
- (18) BOMBICCI, LUIGI. Considerazioni sopra la classificazione adotta per una collezione di litologia generale, con quadri sinottici e catalogo sistematico. *Mem. Accad. Sci. Inst. Bologna* (ser. 4), vol. v., 1884.  
BOMBICCI, LUIGI. *Corso di litologia*. 12mo. Bologna, 1885.
- (19) BONNEY, T. G. Anniversary Address of the President (of the Geological Society). *Quart. Journ. Geol. Soc.*, vol. xli. *Proc.*, pp. 57-96, 1885. [The author attaches importance in the first place to chemical (and by implication, mineralogical) composition, and secondly to "the physical condition of a rock, whether hyaline or not, the relation of its constituents and the like". He recognises fifteen principal groups founded on these descriptive characters.]
- (20) KALKOWSKY, ERNST. *Elemente der Lithologie*. 8vo. Heidelberg, 1886. [Rocks of all kinds are distributed in thirty-nine families, which are merely grouped as "anogene" and "katalogene". These divisions correspond approximately to eruptive and sedimentary, except that the latter is made to include gabbros and peridotites, as well as the crystalline schists and allied rocks.]
- (21) JOHNSTONE, A. On the Evolution and Classification of Igneous Rocks. *Trans. Geol. Soc. Edin.*, vol. v., pp. 412-420, 1887.

- (22) ROSENBUSCH, H. *Mikroskopische Physiographie der Massigen Gesteine*, second edition, revised. 8vo. Stuttgart, 1887. [The primary grouping is into "Tiefengesteine," "Ganggesteine," and "Ergussgesteine," and these groups are divided into families on mineralogical grounds. The division into "Aeltere" and "Jüngere," which held a first place in the author's table of 1882, is here abandoned in principle, but retained in practice in the case of the volcanic rocks.]
- (23) LÉVY, A. MICHEL. *Structures et Classification des Roches Éruptives*. 8vo. Paris, 1889. [With strictures on the preceding. The classification arrived at is not essentially different from that given by the author, in conjunction with Fouqué, in 1879.]
- (24) BERTRAND, MARCEL. Sur la distribution géographique des roches éruptives en Europe. *Bull. Soc. Géol. Fr.* (3), vol. xvi., pp. 573-617, 1888.
- (25) TEALL, J. J. HARRIS. *British Petrography: with special reference to the Igneous Rocks*. Royal 8vo. London, 1888. ["The classification is essentially a mineralogical one; but the rocks are arranged as far as possible according to Bunsen's law."]
- (26) JUDD, JOHN W. The Natural History of Lavas as Illustrated by the Materials ejected from Krakatoa. *Geol. Mag.*, pp. 1-11, 1888.  
JUDD, JOHN W. The Propylites of the Western Isles of Scotland, and their Relation to the Andesites and Diorites of the District. *Quart. Journ. Geol. Soc.*, vol. xlvi., pp. 341-384, 1890.
- (27) ROSENBUSCH, H. Ueber die chemischen Beziehungen der Eruptivgesteine. *Tsch. min. u. petr. Mitth.* (N.S.), vol. xi., pp. 144-178, 1889. [Developing the author's "nucleus" (Kern) theory as the basis of a chemical grouping of igneous rocks.]
- (28) ROTH, J. Die Eintheilung und die chemische Beschaffenheit der Eruptivgesteine. *Zeits. Deuts. Geol. Ges.*, vol. xlili., pp. 1-42, 1891. [A detailed criticism of the preceding.]
- (29) LÖWINSON-LESSING, F. Etude sur la composition chimique des roches éruptives. *Bull. Soc. Belge. Géol.*, vol. iv., 1890. [The author has arrived empirically at formulæ expressing relations between silica and bases in igneous rocks, reduced to eight chemical types, and these he finds to correspond with groups defined by mineralogical characters. A table is given.]
- (30) LANG, HEINR. OTTO. Ueber die Individualität der Gesteine. *Tsch. min. u. petr. Mitth.* (N.S.), vol. xi., pp. 467-486, 1890.

- LANG, HEINR. OTTO. Das Mengenverhältniss von Calcium, Natrium und Kalium als Vergleichpunkt und Ordnungsmittel der Eruptivgesteine. *Bull. Soc. Belge. Géol.*, vol. v., pp. 123-146 (and French abstract, pp. 192-196), 1891.
- LANG, HEINR. OTTO. Versuch einer Ordnung der Eruptivgesteine nach ihrem chemischen Bestande. *Tsch. min. u. petr. Mitth.* (N.S.), vol. xii., pp. 199-252, 1891.
- LANG, HEINR. OTTO. Beiträge zur Systematik der Eruptivgesteine. *Ibid.*, vol. xiii., pp. 115-169, 1892. [An essay towards a purely chemical system, based on the relative proportions of Ca, Na, and K in the bulk-analysis.]
- (31) ADAMS, FRANK D. Notes to Accompany a Tabulation of the Igneous Rocks based on the System of Professor H. Rosenbusch. *Canad. Rec. Sci.*, pp. 463-469, 1891, with table.
- (32) ROSENBUSCH, H. Ueber Structure und Classification der Eruptivgesteine. *Tsch. min. u. petr. Mitth.* (N.S.), vol. xii., pp. 351-396, 1891.
- (33) IDDINGS, JOSEPH PAXSON. The Origin of Igneous Rocks. *Bull. Phil. Soc. Washington*, vol. xii., pp. 89-214, 1892. [The special feature of Iddings' work is a graphical method of comparing rocks by means of diagrams expressing the variations of their bulk-composition.]
- (34) ZIRKEL, FERDINAND. *Lehrbuch der Petrographie*. second edition, 3 vols. 8vo. Leipzig, 1893-4. [With a discussion of the principles of classification, vol. i., pp. 829-842. The prime division adopted is that between the even-grained rocks (chiefly plutonic), and the porphyritic and glassy (chiefly volcanic), the latter being divided into pre-Tertiary and Tertiary (with post-Tertiary). The mineralogical divisions are based in the first place on the predominance of alkali-felspars or lime-soda-felspars or the absence of any true felspar, and secondly upon quartz and the ferromagnesian minerals.]
- (35) BRÖGGER, W. C. Die Eruptivgesteine des Kristianiagebietes. I. Die Gesteine der Grorudit-Tinguait-Serie. *Vidensk. Skr. (Math. naturv. Klasse)*, No. 4, 1894.
- (36) ROSENBUSCH, H. *Mikroskopische Physiographie der Massigen Gesteine*, third edition, enlarged and revised. 8vo. Stuttgart, 1895. [First part only. The author, while admitting the essential identity of the older and younger volcanic rocks, still retains the distinction.]

ALFRED HARKER.

## PAWLOW'S RESEARCHES ON THE PHYSIOLOGY OF SECRETION.

THE researches of Pawlow, of which I wish to give a short account in the following pages, are worthy of attention, not only by reason of their importance in filling a much-felt void in our physiological knowledge, but also because they embody a new departure in physiological method.

It might have been thought, when Ludwig, in 1851, discovered the innervation of the salivary glands, and showed that, by stimulation of certain nerves, a secretion of saliva could be invariably invoked, that our knowledge of the innervation of the other glands of the body would rapidly have been completed. Yet up to the date of Pawlow's researches the two most important secretions which are poured into the alimentary canal, *i.e.*, the pancreatic and gastric juices, although the subjects of numerous investigations, had foiled all attempts to discover the nervous impulses which control their production.

This want of success of the various experimenters is not to be wondered at when we consider the conditions under which so-called "physiological" experiments are usually carried out. It is a matter of common experience that the digestion of food, *i.e.*, the secretion of active digestive juices, is intimately dependent on the well-being, mental or physical, of the animal, and is absolutely checked by abnormal conditions, such as fright, pain, administration of narcotics (opium, chloroform, alcohol, etc.). Now in most experiments the dog or other animal employed is first poisoned with a large dose of morphia, is rendered fully anaesthetic with chloroform or ether, and in many cases is also poisoned with curare. If anaesthetics are omitted the animal is tied down and subjected to an extremely painful operation. It is under circumstances such as these that experiments on the innervation of the gastric and pancreatic glands have failed to have any definite results.

One other difficulty in experimenting on these glands

lies in the fact that the nerves supplying them (vagi and splanchnics) exert a powerful influence on the vascular system—an influence which might presumably affect or check altogether any secreto-motor functions that these nerves might possess.

Pawlow has succeeded in avoiding both these sources of error, and in proving conclusively the existence of definite secretory nerves to both stomach and pancreas. I will deal first with his researches on the pancreas.

Claude Bernard, in 1856, showed that a secretion of pancreatic juice might be evoked by introduction of ether into the stomach, and that a secretion already in progress was checked if vomiting occurred, both facts pointing to the existence of a distinct reflex nervous mechanism presiding over the secretion. This conclusion was further strengthened by the experiments of Bernstein (1869), who showed that the pancreas might be reflexly affected through the vagus (afferent) in two ways, and therefore concluded that this gland was provided with two sets of nerves, excitatory and inhibitory. Attempts, however, to find the efferent channels of these impulses failed.

In 1875 Heidenhain pointed out that direct excitation of the medulla, under certain circumstances, might call forth a pancreatic secretion, but failed, like his predecessors, in distinguishing the efferent nerves carrying the secreto-motor impulses.

Later on (1877) Pawlow and Afanassiew showed that excitation of the central end of all sensory nerves, and not only of the vagus, inhibited an already existing flow of pancreatic juice.

A consideration of these various experiments enables us to perceive certain precautions which would have to be taken in any subsequent experiments on the subject. There must be no excitation of sensory nerves in carrying out the preliminary part of the experiment. On the other hand, it is not permissible to make use of drugs or anaesthetics to depress the sensibility. In exciting the vagus steps must be taken to prevent simultaneous excitation of the cardio-inhibitory fibres.

Pawlow has pointed out two methods by which these aims may be accomplished. In the first method a permanent pancreatic fistula is established, and at the same time one vagus is exposed in the neck, ligatured and divided. The ligature is left hanging from the wound, so that at any subsequent period the nerve may be drawn out and stimulated without any discomfort to the animal. Three days afterwards, without any preliminary anaesthesia, the cut vagus is stimulated with any ordinary faradic current. The invariable result of the stimulation is a secretion of pancreatic juice which flows from the fistula and can be collected in the usual way. The latent period intervening between stimulation and secretion varies between fifteen seconds to two or three minutes. No effect is produced on the cardiovascular system, the inhibitory nerves having degenerated in consequence of the section. Injection of atropin stops secretion, and prevents the effect of stimulating the vagus.

In the second method, the preliminary operation is dispensed with. In this case it is of course necessary to prevent the inhibitory impulses, which are started by the operative stimulation of sensory nerves, from reaching the gland. To this end, Pawlow, in the unanaesthetised animal, rapidly performs tracheotomy and division of the spinal cord just below the medulla, these two operations in his hands not occupying more than half a minute. The impulses which inhibit secretion seem to act reflexly through the medulla, so that they are in this way cut off from the gland. He then resects three or four ribs in order to expose the vagi below the point where they give off their cardiac branches, and finally makes a temporary pancreatic fistula. Stimulation of the vagi below the heart now gives rise to a secretion or increases the secretion already present. Using this method it is better to stimulate the vagi mechanically by means of Heidenhain's tetanomotor or to use single induction shocks at intervals of one second, instead of the faradic current.

The reason for this superiority of single shocks over the faradic current possibly lies in the fact that the vagus may include vaso-constrictor fibres to the pancreas. Pawlow

shows in his paper that the activity of the pancreas is largely dependent on its blood supply—a temporary anaemia of the gland induced by obstruction of the aorta or by stimulation of the splanchnics causing a total suppression of pancreatic activity, which may last several hours.

The second paper on pancreatic innervation, by Mett, deals chiefly with the influence of the vagus on the production of the pancreatic ferments and especially of trypsin. For the determination of the comparative proteolytic powers of the various specimens of pancreatic juice, he employs a new and simple method which presents considerable advantages over the old carmine-fibrin method of Grützner. Capillary glass tubes of 1 mm. bore are filled with egg albumen, which is then coagulated by insertion for five minutes into water at 95° C. They are then cut by a special machine into lengths of 1 cm. Two of these small tubes are placed in each sample of fluid, whose proteolytic powers it is desired to determine, and the whole is kept for seven hours at 40° C. The amount of albumen remaining at the end of the time is read off by means of a micrometer, and the digestive powers expressed by the number of mm. that have been digested. Thus, if the column of undigested albumen was three mm. in length, the digestive power of the fluid would be represented by seven.

In the first place, Mett shows that the pancreatic juice obtained by stimulating the vagus is active on all three classes of food stuffs, and can therefore be regarded as normal. It is an interesting fact that the pancreatic juice obtained in this way from fasting animals is actively proteolytic, whereas it is well known that a fresh extract of the same glands would contain no trypsin. In the second place, in cases where there is already a secretion of pancreatic juice on stimulation of the vagus, we get, not only increased secretion of fluid, but also increased formation of the ferment, so that the juice obtained after stimulation of the vagus is much more active than that obtained before. It is evident then that the vagus contains, to use Heidenhain's nomenclature, not only secretory but also trophic fibres to the pancreas.

In the third paper, by Kudrewetzky, the most interesting results refer to the action of the sympathetic and splanchnics on the pancreas. I have already mentioned that ordinary faradic stimulation of the splanchnics causes anaemia of the gland and consequent cessation of its activity. It is well known, however, that if we stimulate a "mixed nerve" by single induction shocks or mechanical means, the vaso-constrictor effects are little marked or absent. If these modes of stimulation be applied to the splanchnics or to the thoracic sympathetic, a secretion of pancreatic juice is evoked together with an increased formation of trypsin. The same effect may be produced with ordinary faradic stimulation if the splanchnics be divided six days previously so as to allow time for the vaso-constrictor fibres to degenerate. Kudrewetzky concludes that the splanchnics, as well as the vagi, contain secreto-motor and tryptogenic or trophic fibres to the pancreas.

#### THE INNERVATION OF THE GASTRIC GLANDS.

Still more striking and interesting are Pawlow's researches on the innervation of the stomach. In this case, as in the case of the pancreas, previous researches had added but little to our positive knowledge of the subject. As long ago as 1852, Bidder and Schmidt showed that in a dog with gastric fistula, the sight of food caused a secretion of gastric juice. In 1878 Richet published a series of interesting observations on a man with complete occlusion of the oesophagus and a gastric fistula. In this patient the mastication of sour or sweet things caused a copious secretion of gastric juice. Hence there could be no doubt that the nervous system has control over the gastric glands, and that some nerves exist carrying secreto-motor impulses to the stomach. Attempts to distinguish these nerve channels were however without success.

In experimenting on this point it is necessary that the animal should be in as normal a condition as possible, and that all escape of the saliva through the oesophagus into the stomach should be prevented. Pawlow carried out, therefore, the following operation. He first made a gastric

fistula, and a few days later exposed the œsophagus in the neck, divided it, and sewed the two cut ends to the two corners of the wound in the neck. The animal was fed by pouring milk or broth through the lower end of the œsophagus, or by the direct introduction of meat into the stomach. Any food taken by the mouth or any saliva secreted in the mouth and swallowed fell out of the opening of the œsophagus in the neck, and so was perfectly shut off from the stomach. After the operation the dogs diminished in weight for a few days, and then rapidly accommodated themselves to the altered mode of feeding, and increased in weight and remained in excellent condition for many months. In such animals it was easy to bring about reflexly a copious secretion of gastric juice. To this end it is only necessary to starve the animal for nine hours, and then give it a meal of meat to eat. The dog devours the meat with avidity, masticates it, but none of the meat reaches the stomach since it all falls out of the opening of the neck. The dog's appetite remaining therefore unappeased, he will go on eating for a very long time. The effect of this sham feeding is to call forth a reflex secretion of gastric juice. Between the feeding and the secretion a long, constant, latent period of five to six minutes intervenes. I may here quote one experiment to show the pronounced effect on the activity of the gastric gland, which is thus produced :—

Time.	Gastric juice secreted in five minutes.	} Gastric juice contains a considerable amount of mucus.
12.30	4.0 ccm.	
12.35	3.0 "	
12.40	3.0 "	
12.45	2.4 "	

At this point the dog begins to eat meat.

12.50	1.8 ccm.	} The gastric juice is almost completely free from mucus.	
12.55	10.8 "		
1.0	15.4 "		
1.5	17.8 "		
Feeding stopped.			
1.10	16.0 ccm.		
1.15	12.0 "		
1.20	10.8 "		

This reflex secretion only occurred when meat was eaten and not when water, milk, or soup was given to the dog. It is interesting to note that in many cases merely showing the meat to the hungry dog would cause a secretion of gastric juice, and that this secretion stopped as soon as the dog recognised that he was being teased, and was not intended to have the meat—an instance of the influence of psychical events on the processes of digestion, of which we have so many examples in our daily life.

Here at last we have a means of obtaining a perfectly pure gastric juice free from all admixtures with foreign substances, such as food or saliva. The characters of this pure gastric juice have been investigated more nearly by Pawlow's pupil, Schoumow-Simanowsky. When secreted it is perfectly clear and colourless, its sp. gr. varying from 1003 to 10,059. It is feebly dextrorotatory, gives no biuret reaction, but gives the ordinary reactions (xanthoproteic, etc.) for proteids. It inverts cane-sugar and is strongly proteolytic. Its total solids vary from .292 to .60 per cent.; ash from .10 to .160 per cent. It is strongly acid, the acid varying between .46 and .58 per cent. HCl.

An extremely interesting point about this juice is that, when cooled to 0°, it deposits a fine powdery precipitate which appears to consist of pure pepsin. When this precipitate has fallen to the bottom, it is found that the acidity of the fluid increases from the top to the bottom. Thus in one case the upper layer contained .45 per cent. HCl, while a sample from the lower layer contained .63 per cent. HCl. In another case, the upper layer contained .4 per cent., the middle .45 per cent., and the lower layer .11 per cent. HCl. This increase of acidity in the lower layers shows that the acid must be in a condition of loose combination with the pepsin, and is therefore carried down with this body when it is precipitated by means of cold.

By treating large amounts of gastric juice, it is possible to obtain sufficient of this cold precipitate for analysis. The precipitate forms an extremely light powder which gives all the proteid reactions. Even after thorough washing it presents a markedly acid reaction, and in solution gives the tests

for free hydrochloric acid. It is easily soluble in water or glycerine. The watery solution gives a pp. on cooling to  $0^{\circ}\text{C}$ . and coagulates on heating to  $60^{\circ}\text{C}$ . It digests proteids readily. The active body, or pepsin, can also be obtained from gastric juice by saturation with ammonium sulphate, as Kühne has already pointed out. The pepsin obtained in this way agrees very closely with that obtained on cooling the gastric juice, as is shown by the subjoined elementary analysis of two samples of pepsin obtained in these two different ways.

Pepsin Precipitated by Cold.	Pepsin Precipitated by $\text{Am}_2\text{SO}_4$ .
Carbon, -	50·73 per cent.
Hydrogen,	50·37 per cent.
Chlorine, -	6·88 "
Chlorine, - 1·17 and 1·01	0·89 and 0·89 "
Sulphur, -	1·35 and 1·34 "
Nitrogen, -	14·55 and 15·0 "

We have now to inquire what is the path of the reflex from the nervous centres to the stomach. If both splanchnics be divided in one of the dogs with gastric and oesophageal fistulae, the dog after an attack of diarrhoea returns to a practically normal condition. Under these circumstances, it is found that the sham feeding is followed, as in the case of normal dogs, by a copious secretion of gastric juice. It is evident that the splanchnics do not carry the efferent impulses of the reflex act. The next step was to divide both vagi, and here certain precautions were necessary. Division of both vagi in the neck causes paralysis of the larynx and oesophagus, and death after two or three days from pneumonia. To avoid this catastrophe, Pawlow proceeded in the following manner : On one day in the anaesthetised animal, the gastric fistula was instituted, and then the right vagus exposed low down in the neck by an incision outside the sternomastoid, and divided below the subclavian artery, *i.e.*, below the point where it gives off its recurrent branch. The operations were of course performed with strict aseptic precautions, and the animals recovered rapidly. When they were quite well the double oesophageal fistula was made. A few days later, after recovery from the second operation, the animal was placed in a special holder made

for the purpose, and arrangements made for collecting gastric juice. A sham feeding was followed by the usual results. The left vagus was then rapidly exposed and divided without anaesthesia, and meat again presented to the dog. He devoured it as eagerly as before, but now not a single drop of gastric juice was secreted. After this double division of the vagi, the animal remained in fair condition for three or four days, but during the whole of this time the reflex secretion was absolutely abolished, showing that the vagi carry the secretory impulses from the central nervous system to the stomach. At the end of this time digestive troubles supervene. The food remains in the stomach and undergoes putrefaction in consequence of the absence of the normal acid secretion. The dog wastes rapidly and dies of a species of septicæmia, or of exhaustion consequent on continual vomiting. This mode of death, in consequence of division of both vagi, has also been described by O. Frey.

In all cases where we would study the functions of a nerve or nerve centre, we have two experimental criteria to guide us, *i.e.*, abolition of function or paralysis in consequence of division of tracts, induced or increased functional activity in consequence of excitation. An application of the second method in the case under discussion confirms the conclusion derived from the effects of section of the vagi. Here, as in dealing with the pancreas, we must take steps to avoid the usual cardio-inhibitory effects of stimulating the vagus. This aim can be attained by dividing the left vagus twenty-four hours before the excitation. I have already mentioned that after this double division of the vagus, the animal remains in a fairly normal condition for two or three days, although there is no secretion of gastric juice. If, however, twenty-four hours after division of the second vagus, the nerve be drawn out of the wound and stimulated, a secretion of gastric juice is the invariable result. Here, as in the case of the reflex secretion, there is a constant latent period of five to six minutes intervening between the application of the stimulus and the appearance of the first drop of secretion, showing that the delay is due to processes having their seat in the gastric mucous membrane itself.

It is better, for the reasons already given, to use rhythmically repeated induction shocks of one a second than the ordinary faradic current.

We must conclude that the vagus carries the secretory fibres both to the gastric glands and to the pancreas.

Although this conclusion is a most important acquisition to physiological science, yet I think still greater value must be attached to the methods employed in arriving at it. I cannot do better than quote Pawlow's own account of the causes which had led him to a successful solution of the problem. "It is clear that the ordinary traditional mode of carrying out a physiological experiment in which the animals are subjected to the influence of the various poisons, as well as to severe operations at the time of the experiment, involves dangers which are not sufficiently appreciated by physiologists. Many physiological phenomena may in consequence of these conditions be absolutely abolished, or, if observed, may present marked deviations from the normal. There is no doubt that these methods have rendered most excellent service. Yet it seems probable that physiology is fast approaching the time when it must seek for new experimental methods—methods in which our chief aim must be to diminish as far as possible the deviation of the animal from the normal." We have, in fact, to introduce physiological methods into physiological research.

Although they are not directly connected with the question of the innervation of the glands, yet the researches of Simanowsky, in conjunction with Professor Nencki, on the urine of animals, in whom the gastric juice is allowed to leave the body, are worthy of notice. As might be expected, the effect of this loss of gastric juice is to make the urine strongly alkaline and turbid with phosphates. On adding acid to the urine, it effervesces from the presence of alkaline carbonates. The urine is free from albumen or sugar. Chlorides are entirely absent, while the potassium and sodium salts are largely increased. The latter, in fact, may be increased to ten times its normal amount. This fact shows that, as suggested by Maly, the hydrochloric acid of the gastric juice is derived from dissociation of

the sodium chloride in the blood. Under normal circumstances the hydrochloric acid is reabsorbed from the alimentary canal with the reformation of sodium chloride. In Pawlow's dogs, however, the hydrochloric acid being allowed to flow away through the fistula, the soda set free in the blood had to be excreted by the kidneys.

Since the sodium chloride is split up to form the hydrochloric acid of the gastric juice, it seemed worth while to find out what would happen if the Na Cl in the blood were replaced by Na I or Na Br. Dogs which had been operated on in the usual way were fed on meat, milk, and bread which had been baked without the addition of salt. To their diet was added first two grammes and then six grammes of sodium iodide or sodium bromide as might be desired. In the experiments, in which sodium bromide was added, the dogs became, after fourteen days, so ill and sleepy that the experiment had to be stopped, and one dog died. Sodium iodide, however, did not seem to affect the dogs in the slightest respect. The dose could be increased far above the amounts mentioned above without producing any ill effects. What is the cause of this difference between the two drugs? The examination of the urine and gastric juice in the two sets of experiments at once threw light on the cause of this divergence. In the dogs which were fed with sodium bromide, the gastric juice was secreted normally and its acidity was slightly increased, but the acidity was due largely to the presence of free hydrobromic acid. In one sample more than one half the total acidity was due to hydrobromic acid. In this way a large amount of the bromide taken in was eliminated. A certain amount was also got rid of in the urine, and it is worth noting that the excretion of bromide in the urine continued for many days after the administration of the bromide had been discontinued. On the other hand, in the dogs fed with sodium iodide the gastric juice contained only minute traces of hydroiodic acid or of iodide, the chlorides present being sufficient to account for the total acidity. In these animals practically the whole of the iodide was eliminated by the kidneys, the elimination being complete within two or three days after discontinuing the drug.

We see, then, that these two closely related classes of compounds, iodides and bromides, are fundamentally different in their behaviour with relation to the dog's organism. The bromides are taken up by the cells, where they can replace the chlorides, and in the cells of the gastric glands they are split up into free acid and alkali, just as are the chlorides. Since they are thus built up into the living framework of the body, their elimination is slow. The fact, however, that dogs die under their administration shows that the representation is not complete, and that the animal cell cannot for all its purposes utilise the bromides.

The iodides, on the other hand, cannot replace the chlorides, and are probably only taken up by the cells of the body to a very small degree. They pass through the body in solution in its juices, leaving its cells and their well-being unaffected, and are rapidly excreted in the urine. These few experiments seem to offer us prospects of a further insight into the chemical affinities of living protoplasm, and it is to be hoped that they are merely the first instalment of a long series of similar comparative experiments on the reaction of the living body to allied chemical substances.

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E. H. STARLING.

## APPENDIX I.

### NOTICES OF BOOKS.

*A Text-book of Physiology.* By M. Foster, M.A., M.D., LL.D., F.R.S., Professor of Physiology in the University of Cambridge. Sixth Edition. Part ii. comprising Book ii. The Tissues of Chemical Action with their Respective Mechanisms. Nutrition. London : Macmillan & Co., 1895.

The changes which have been made in the present edition of this text-book are merely such as to bring it up to date. But the book is slightly larger than its predecessor and is greatly improved by the addition of a separate index.

One is, however, tempted to ask whether still further improvements might not be made. The book has now been before the public sufficiently long to make it possible to form some idea of the class of men who use it, and as to whether it is perfectly adapted to their requirements.

So far as the ordinary medical student is concerned the unanimous opinion will be that it is too large, *i.e.*, it contains more than such men really want; moreover, there is always the very greatest difficulty in getting such men to read even a one-volume book properly, to say nothing of one of four or five volumes. And, indeed, the treatment of the whole subject is not such as is best suited to the medical student's needs; it is too much in essay form, and the facts are not brought out with sufficient prominence; so that although after reading up a subject in it a man could write a good essay on the special branch of physiology treated of, he would not be able to produce the answers expected in such an examination as that conducted by the Conjoint Board. For such men a book in itself less perfect, but with the facts more clearly stated and theories less fully set forth, is better adapted.

The men for whose wants Foster's *Physiology* is particularly well adapted are those who are reading for University examinations or for the higher examinations in London, such as the Fellowship of the Royal College of Surgeons. For these men are always students with abilities somewhat above the average, who have decided to devote sufficient time to physiology to gain a good general idea of the subject, and they find that a book to be useful to them must be full, and special attention must be paid to the theories held on the various points. But upon many subjects opposite theories are held, and it is surely well that these students should have some idea of the men who originated such theories, and should be able in certain cases to apply to the original papers for fuller information than any text-book affords, in order that they may be able to form their own opinion on the subject. Already there is far too much veneration for "authority" in science, especially amongst the younger generation, and it is rare to find even an advanced student who has really formed an opinion for himself after looking up the more important papers on any given subject.

Dr. Foster's text-book fails here: it is almost without names, and without references to original papers. We are aware that the plan of excluding such references has been adopted after much and careful consideration, but as the book has increased so much in size since the first edition was published in 1876 it surely appeals to a different class of students, and it is in the interests of these men that we venture to suggest a change. Admirable as far as it goes, it yet does not go far enough for our best students, for, as Dr. Waller points out, it is of great importance that these men should be made familiar with the "growing edge" of the science. We are exceedingly glad to notice that Dr. A. Sheridan Lea has been able to help Dr. Foster in the preparation of the present edition.

*A Primer of Evolution.* By Edward Clodd. London: Longmans, Green, & Co., 1895.

The question which immediately occurs to us in glancing through this book is, "Why was it written?" It is difficult to believe that it will serve any useful purpose, for all the information it contains is to be found in more convenient form and certainly accompanied by far better figures in other books equally accessible to the average student.

We fear Mr. Clodd's book will scarcely help to popularise a knowledge of evolution.



## APPENDIX II.

### ENUMERATION OF TITLES OF CHEMICAL PAPERS APPEARING IN JULY, 1895.

Vol. ix. No. 243. *The Philosophical Magazine and Journal of Science.*  
(August, 1895.)

*Buchanan, F.*, The Use of the Globe in the Study of Crystallography (pp. 153-172). *Kuchen,*  
*Dr.*, Condensation and Critical Phenomena of Mixtures of Ethane and Nitrous Oxide  
(pp. 173-194). *Olszewski, K.*, Determination of the Critical and the Boiling Temperature  
of Hydrogen (pp. 202-210). *Wanklyn, J. A.*, and *Cooper, W. J.*, Fractional Distillation  
applied to American Petroleum and Russian Kerosene (pp. 225-228).

Vol. lviii. No. 348. *Proceedings of the Royal Society.*

*Ramsay, W.*, A Gas showing the Spectrum of Helium, the Reputed Cause of D<sub>3</sub>, one of the  
Lines in the Coronal Spectrum (pp. 65-67). *Lockyer, J. N.*, On the new Gas obtained  
from Uraninite (pp. 67-70). *Fraser and Tillie*, *Acokanthera Schimperi*, Its Natural  
History, Chemistry, and Pharmacology (pp. 70-73).

Tome 5. *Annales de Chimie et de Physique.* (August, 1895.)

*Camichel, C.*, Étude experimental sur l'absorption de la lumière par les cristaux (pp. 433-493).  
*Berthelot*, Mémoire sur la Thermochemie de carbures d'hydrogène (pp. 493-567). *Moissan*  
et *Gaulier*, Nouvelle méthode pour la détermination de la densité des gaz (pp. 568-573).  
*Berthelot*, Sur la fusion de la Silice pendant la combustion explosive de la dynamite (pp.  
573-574).

Tomes xiii.-xiv. No. 14. *Bulletin de la Société Chimique de Paris.*  
(20th July, 1895.)

*Cazeneuve et Haddon*, Les causes de la coloration et de la coagulation du lait par la chaleur,  
formation de l'acide formique aux dépens de la lactose (pp. 737-740). *Degrez*, Nouvelle  
synthèse de quelques nitriles aromatiques (pp. 735-737). *Tanret, C.*, Sur les modifications  
moléculaires de glucose (pp. 728-735). *Tassillo*, Sur quelques combinaisons halogénées  
basiques des métaux alcalino-terreux (pp. 725-727). *Thomas, V.*, Action du peroxyde  
d'azote sur les sels halogénés d'antimonie (pp. 722-725). *Sisley, P.*, Sur le pouvoir tinctorial  
des phénols pour les mordants ferriques (pp. 740-743).

Tomes xiii.-xiv. No. 15. (5th August, 1895.)

*Bouchardat et Tardy*, Sur les alcools dérivés de l'eucalyptene (pp. 765-769). *Dupont, J.*,  
Recherche de l'huile de coton dans les Saindoux Américains (pp. 775-780). *Guerbet, M.*,  
Sur l'acide isocampholique (pp. 769-775). *Jean, F.*, Analyse du Saindoux et des grasses  
similaires. Recherche des huiles végétales (p. 780). *Massol, G.*, Sur les points de fusion  
et de solidification de quelques acides de la série grasse (pp. 758-759). *Varet*, Récherches  
sur sels mercurieux (pp. 759-765).

Tome cxxi. No. 2. *Comptes Rendus hebdomadaires de l'Académie des Sciences.*  
(8th July, 1895.)

*Grimaux, E.*, Action du chlorure de zinc sur la résorcin (pp. 88-91). *Lecq de Boisbaudran*,  
Volumes des sels dans leurs dissolutions aqueuses (pp. 100-102). *Haller et Guyot*, Sur  
la diphenylanthrone (pp. 102-106). *Hubault, P.*, L'existence de phosphore en proportion  
notable dans les Huitres (p. 111). *Duboin, A.*, Quelques méthodes de reproduction des  
fluorures doubles et des silicates doubles formés par la potasse avec les bases (p. 111).  
*Duboin, A.*, Analyse de la leucite et de la néphéline purement potassique (p. 111). *Pallas*,  
Surpression dans les minéraux de houille (p. 112).

Tome cxxi. No. 3. (15th July, 1895.)

*Carnot, A.*, Sur un gisement de phosphates d'alumine et de potasse trouvé en Algérie, et sur la genèse de ces minéraux (pp. 151-155).

Tome cxxi. No. 4. (22nd July, 1895.)

*Girard, A.*, et *Lindel, L.*, Recherches sur la composition des raisins des principaux cépages de France (pp. 182-187). *Raoult*, Sur les phénomènes osmotiques qui se produisent entre l'éther et l'alcool méthylique, à travers différents diaphragmes (pp. 187-189). *Haller, A.*, Action de l'isocyanate de phényle sur quelques acides et éthers (pp. 189-193). *Gaston, S.*, Un phénomène de phosphorescence obtenu dans les tubes contenant de l'azote rarefié après le passage de la décharge électrique (pp. 198-199). *Mourlot, A.*, Sur le sulfure de manganèse anhydre cristallisé (pp. 202-204). *Thomas, V.*, Sur quelques propriétés des combinaisons de chlorure ferreux et de bixyde d'azote (pp. 204-206). *Hugot, C.*, Sur quelques phosphures alcalins (pp. 206-208). *Massol* et *Guillot*, Chaleurs spécifiques des acides formique et acétique sur fondus. Modifications à apporter au thermocalorimètre de Regnault, en vue de la détermination de chaleurs spécifiques d'un grand nombre de liquides sur fondus (pp. 208-210). *Henry, L.*, Formation synthétique d'alcools nitrés (pp. 210-213). *Behal, A.*, Oxydation de l'acide campholenique inactif (pp. 213-216). *Fleurent, E.*, Constitution des matières albuminoïdes végétales (pp. 216-219). *Maze, l'Abbé*, Le premier thermomètre à alcool utilisé à Paris (pp. 230-231).

Tome cxxi. No. 5. (29th July, 1895.)

*François, M.*, Action de l'aniline sur l'iode mercureux (pp. 253-256). *Behal et Blaise*, Action de l'hypoazotide sur l'acide campholenique (pp. 256-259). *Kohn, L.*, Sur les produits de condensation de l'aldehyde isovalérique (pp. 259-260).

15<sup>e</sup> Année. Tome ii. No. 2. *Journal de Pharmacie et de Chimie.*  
(15th July, 1895.)

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15<sup>e</sup> Année. Tome ii. No. 3. (1st August, 1895.)

*Bourquelot, E.*, Maltase et fermentation alcoolique du maltose (pp. 97-105). *Battand*, Sur la conservation des blés (pp. 105-107). *Gaston, B.*, Notes pour servir à l'histoire chimique de la Cuscute (pp. 107-112).

Band cclxxxvii. Heft 1-2. *Justus Liebig's Annalen der Chemie.*  
(6th July, 1895.)

*Erlenmeyer, E.*, Zur Geschichte der isomeren Bromzimmtsäuren und Zimmtsäuren (pp. 1-26). *Einhorn, A.*, und *Sherman, P.*, Ueber einige im Pyridinkern substituierte Chinolinderivate (pp. 26-49). *Rügheimer*, Ueber Hippurofavin (pp. 50-97). *Jacobson, P.*, Ueber das Verhalten von Azo-phenol-Aethern bei der Reduction mit Zinnchlorür und Salzsäure (pp. 97-102). *Fertsch, F. K.*, *Marsden, F.*, und *Schkolnik, G.*, Reduction der Benzolazokresetole (o- und m-) (pp. 147-161). *Düsterbeck, Klein*, und *Schkolnik, G.*, Reduction von Aethern der Toluolazophenole (pp. 161-183). *Heber, Heinrich*, und *Schwarz*, Reduction der Toluolazokresetole (o- und m-) (pp. 183-211). *Schkolnik, G.*, Reduction des m-Xylolazokresetols (pp. 211-212). *Meyer, F.*, Reduction von Azophenetolen (pp. 212-220). *Hinsberg* und *Strupler*, Ueber Benzolesulfamide und gemischte secundäre Amine III. (pp. 220-230). *Dorn, E.*, und *Erdmann, H.*, Ueber das von Berthelot beschriebene Fluorescenzspectrum des Argons (pp. 230-232).

Band ccxxxiii. Heft 5. *Archiv der Pharmacie.* (31st July, 1895.)

*Flückiger, Friedrich Auguste*, Eingegangene Beiträge.

Jahrgang xxviii. No. 12. Berichte der Deutschen Chemischen Gesellschaft.  
(15th July, 1895.)

- Wegscheider, R.*, Ueber die Esterbildung (pp. 1468-1474). *Wallach, O.*, Berichtigung (pp. 1474-1475). *Philips, A.*, Modification des Soxhlet'schen Extractionsapparates zur Extraction bei Siedetemperatur (pp. 1475-1476). *Kerp, W.*, Notiz ueber die Fähigkeit des gewöhnlichen Alkohols, bei hoher Temperatur reducirend zu wirken (pp. 1476-1477). *Klason, P.*, Ueber die Constitution der Platinverbindungen (pp. 1477-1489). *Klason, P.*, Ueber Platindiammoniakalpyridinverbindungen (pp. 1489-1493). *Klason, P.*, Beiträge zur Kenntniß der Platinäthylsulfidverbindungen (pp. 1493-1501). *Marckwald, W.*, Ueber das Inden und die Constitution der Ringsynthese (pp. 1501-1505). *Cohen, J. B.*, und *Ormandy, R.*, Amalgamirites Aluminium als Reductionsmittel (pp. 1505-1506). *Balbiano, L.*, Ueber die Oxydationsprodukte der Camphersäure (pp. 1506-1508). *Fischer, O.*, Ueber ein neues, dem Amygdalin ähnliches Glucosid (pp. 1508-1511). *Panajotow, G.*, Ueber o-p-Dimethylchinophthalon und o-p-Dimethylchivaldinsäure (pp. 1511-1513). *Kalischer, G.*, Zur Constitution der Isonitrosoketone (pp. 1513-1519). *Kalischer, G.*, Eine Darstellungsweise des Diamidoacetons (pp. 1519-1522). *Lintner, C. J.*, und *Düll, G.*, Ueber den Abbau der Stärke durch die Wirkung der Oxalsäure (pp. 1522-1532). *Goldschmidt, C.*, Ueber Dichlorbenzylidenacetone (pp. 1532-1533). *Lagodzinski, K.*, Ueber 2-3-Dioxyanthrazen (pp. 1533-1535). *Friedlander, P.*, Ueber eine Reaction der  $\alpha$ -Nitronaphthalin-3'-8-disulfosäure (pp. 1535-1537). *Weisse, K.*, Ueber Triphenylthienymethan (pp. 1537-1538). *Thiele, J.*, und *Wheeler, L. H.*, Umlagerung von Hydrazinen in p-Diamine (pp. 1538-1540). *Schneider, E. A.*, Nachweis kleiner Mengen Kaliumcyanat im Cyankali (pp. 1540-1542). *Kehrmann, F.*, und *Tikhvinckij, M.*, Nitrotoluhydrochinon (pp. 1542-1543). *Kehrmann, F.*, Zur Constitution der Fluoridine (pp. 1543-1547). *Böhme, E.*, Ueber zwei verschiedene Formen des Diacetylthymochinondioxims (pp. 1547-1549). *Ciamician, G.*, und *Silber, P.*, Ueber das Phenylcumalin und das sogenannte Diecotoin (pp. 1549-1558). *Hancock, W. C.*, und *Dahl, O. W.*, Die Chemie der Lignocellulosen. Ein neuer Typhus (pp. 1558-1563). *Mylius, F.*, und *Fromm, O.*, Versuche zur Herstellung von reinem Zink (pp. 1563-1576). *Meyer, R.*, Zwei vorläufige Mittheilungen (pp. 1576-1578). *Jaubert, G. F.*, Ueber Beziehung der Safranine zu den Mauveinen und Indulinen (pp. 1578-1585). *Emich, F.*, Bemerkung (pp. 1585-1586). *Bayer, A.*, Ortsbestimmungen in der Terpenreihe (pp. 1586-1603). *Clasen, A.*, und *Löb, W.*, Ueber die Einwirkung von Jod auf Phenolphthalein (pp. 1603-1611). *Morcklewska, L.*, Ueber Racemie (pp. 1611-1612).

Band li. No. 15. *Journal für Praktische Chemie.* (17th July, 1895.)

- Meyer, E. von*, Ueber dimolekulare Nitrile und ihre Abkömmlinge (pp. 81-117). *Curtius, T.*, und *Blumer, A.*, Ueber die Einwirkung von Hydrazinhydrat auf Benzoin und desoxybenzoin (pp. 117-137). *Stolz, F.*, Erwiderung auf die Abhandlung von R. von Rothenburg: zur Constitutionsfrage der n-Phenylpyrazolone (pp. 138-148). *Waltther, R.*, Ueber reduction mittelst Phenylhydrazin (pp. 141-144).

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- Georgievics, G. v.*, und *Löwy, E.*, Ueber das Wesen des Färbeprocesses. Vertheilung von Methylenblau zwischen Wasser und mercerisirter Cellulose (pp. 345-351). *Kulisch, V.*, Zur Kenntniß der Condensationsvergängen zwischen o-Toluidin und  $\alpha$ -Diketonen, sowie  $\alpha$ -Ketonsäureestern (pp. 351-358). *Zulkowski, K.*, Zur Chemie des Corallins und Fuchsins (pp. 358-403).

Band ix. Heft 4. *Zeitschrift für Anorganische Chemie.* (8th July, 1895.)

- Schwarz, F.*, Ueber eine neue Polyphosphorsäure  $H_5P_3O_{10}$ , und einige Verbindungen derselben (pp. 245-267). *Jannasch und Schmitt*, Die quantitative Bestimmung des Fluors durch Austruben derselben als Fluorwasserstoffgas (pp. 267-274). *Jannasch und Schmitt*, Ueber Metalltrennungen in einem chlorwasserstoffstrom (pp. 274-283). *Thomsen, J.*, Ueber die mutmaßliche Gruppe inaktiver Elemente (pp. 283-289). *Priwoznik, E.*, Ueber eine merkwürdige strukturveränderung des Glases durch Erwärmung (pp. 289-299). *Werner und Klein*, Ueber sogenannte amidochromsäure Salze (pp. 291-294). *Hofmann,*

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*K. A.*, und *Wilde, O. F.*, Weitere Mittheilungen ueber Nitrosoverbindungen des Eisens (pp. 295-303). *Wells, H. L.*, Ueber einige Jodverbindungen des Bleis mit ueberschüssigem Jod (pp. 304-311). *Lea, Carey*, Ueber die Beziehung der Farben von atom, ion und Molekul (pp. 312-328).

Band xvii. Heft 3. *Zeitschrift für Physikalische Chemie.* (July, 1895.)

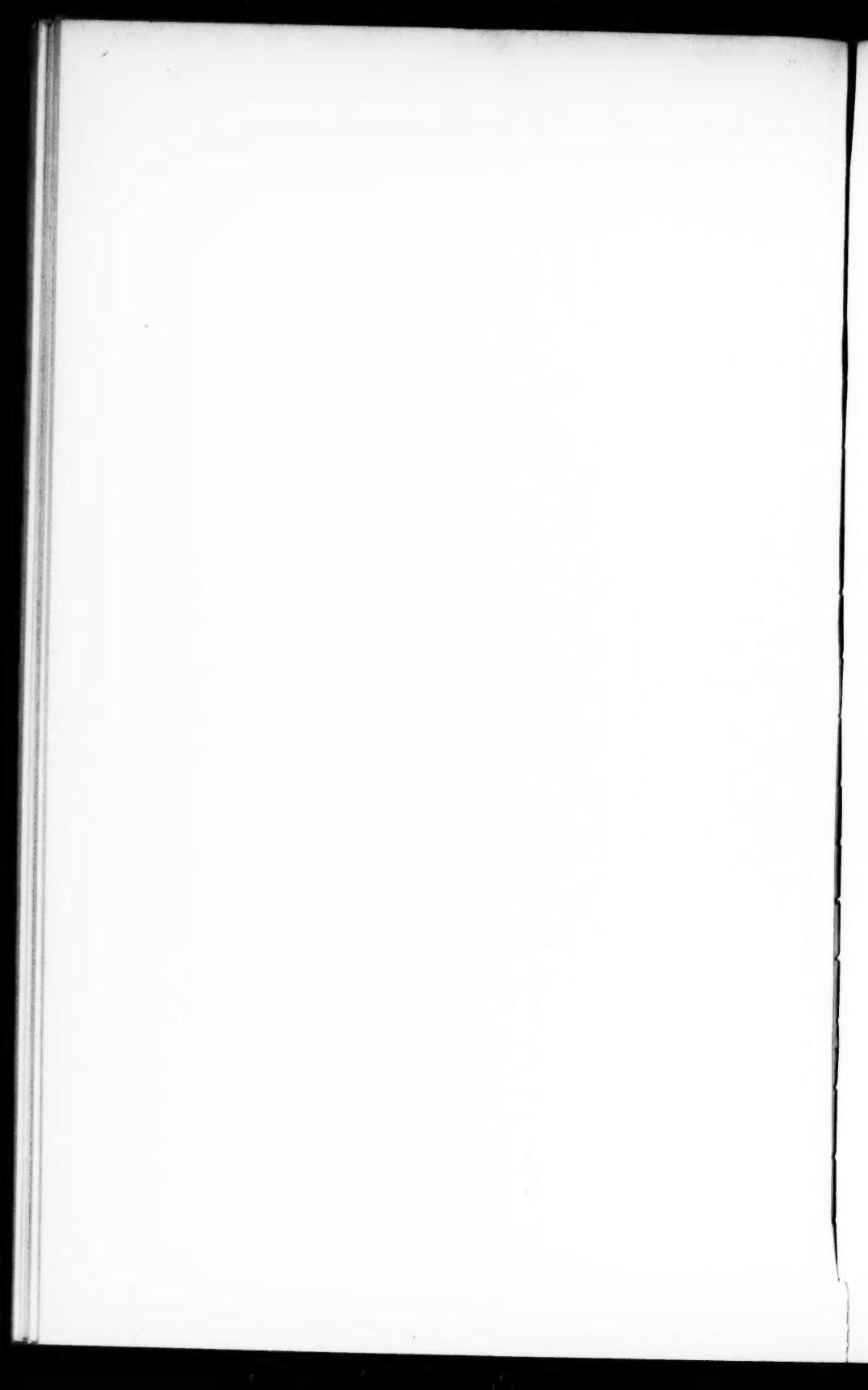
*Rudolphi, M.*, Ueber die Gültigkeit der Ostwaldschen Formel zur Berechnung der Affinitätskonstanten (pp. 385-426). *Ostwald, W.*, Ueber Physiko-Chemische Mess-Methoden (pp. 427-445). *Müller, E. W.*, Ueber den dampfdruck des durch kupfervitriol und durch chlorbaryum gebundenen wassers (pp. 446-458). *Bredig, G.*, Ueber den Einfluss der Zentrifugalkraft auf chemische systeme (pp. 459-472). *Pringsheim, N.*, Ueber chemische Niederschläge in Gallerte (pp. 473-504). *Van 't Hoff und Goldschmidt, J. H.*, Das racemat von Wyronboff (pp. 505-512). *Mayan, J. L. R.*, Die Bestimmung von Cyanionen auf electrometrischen Wege (pp. 513-535). *Sutherland, W.*, Bemerkungen ueber die Thermodynamische Theorie der Kapillarität von Van der Waals (pp. 536-538). *Nasine, R.*, und *Carrara, G.*, Ueber das Brechungsvermögen des Sauerstoffs des Schwefels und des Stickstoffs in den Heterocyclischen Ringen (pp. 539-544). *Van Laar, J. J.*, Zur Berechnung von Losungswärmen aus der Loslichkeit (pp. 545-549). *Köppé, H.*, Bemerkungen zu Hedin's Abhandlung. Ueber die Bestimmung isosmotischer konzentrationem durch zentrifugieren von Blut-mischungen (pp. 552-553). *Jahn, H.*, Berichtigung (pp. 550-551).

Band xxi. Heft 1. *Zeitschrift für Physiologische Chemie.* (25th July, 1895.)

*Wróblewski, A.*, Zur Kenntniss des Pepsins (pp. 1-18). *Roos, E.*, Ueber die Einwirkung der Schilddrüse auf den Stoffwechsel nehl vorversuchen ueber die art der wirksamen Substanz in derselben (pp. 19-41). *Wicke, A.*, und *Weiske, H.*, Ueber den einfluss einer Fett-resp. Stärkebeigabe auf die Ausnutzung der Nährstoffe sowie auf den Stickstoffumsatz und ansatz im Thierischen organismus (pp. 42-67). *Diechsel, E.*, Ueber die reduction alkalischer Kupferlösungen durch eweißkörper (pp. 68-70). *Moraczewski, W. V.*, Ueber das Verhalten des Caseins in ammonialkalischer magnesium chloridlösung (pp. 71-78). *Stoklasa, J.*, Chemische Untersuchungen auf dem Gebiete der Phytospathologie (pp. 79-86)). *Sandmeyer, W.*, Ueber die ausmutzung des Paranucleins im Thierischen organismus (pp. 87-89). *Tichomiroff, M.*, Ueber die Fällung von Toxalbuminen durch Nucleinsäure (pp. 90-96). *Lieblein, W.*, Ueber die Bestimmung der Acidität des Harns (pp. 97-108). *Schulze, E.*, und *Frankfurt, S.*, Berichtigung (p. 108).

Anno xxv. Vol. 1. Fascicolo 6. *Gazetta Chimica Italiana.* (July, 1895.)

*Longi, A.*, Sulla rapida determinazione della sostanza grassa nel latte e sopra un nuovo laci butterometro (pp. 441-451). *Andreucci, A.*, Sui quattro acidi santonosi (pp. 452-567).



## APPENDIX I.

### NOTICES OF BOOKS.

*A Course of Elementary Practical Bacteriology.* By A. A. Kauthack, M.D., M.R.C.P., Lecturer on Pathology and Bacteriology, and Curator of the Museum, St. Bartholomew's Hospital; and J. H. Drysdale, M.B., M.R.C.P., Casualty Physician, St. Bartholomew's Hospital; late Demonstrator of Bacteriology, University College, Liverpool. London: Macmillan & Co., 1895.

In these days of very numerous and often inefficient text-books, it is refreshing to glance through such a thoroughly practical guide as the little volume by Dr. Kauthack and Mr. Drysdale.

In the preface the authors state that they have divulged all their own "short cuts" and "secrets," some of which every laboratory possesses, and which, being regarded as almost sacred, are often withheld from the beginner, with the result that his operations end in failure. We can well believe this, for the details of procedure are most accurately described, and even a tyro, by following the directions, can scarcely go wrong. It is impossible for any one not engaged in teaching to appreciate the difficulty experienced by students in carrying out processes (very numerous in bacteriology) in which success depends almost entirely on care in following out minute details. The volume before us is divided into three parts, part i. dealing with general bacteriology and forming an elementary course arranged to extend over five or six weeks of three lessons a week.

Part ii. is devoted to bacteriological analysis, and includes the preparation of the various media, and the analysis of air, water, food, etc. Parts i. and ii. are especially arranged to suit the requirements of candidates for the Diploma in Public Health.

Part iii. comprises an introduction to bacteriological chemistry.

It is seldom we are able to recommend a book as heartily as in the present instance, and we look forward to seeing this little volume take its place as the best elementary guide to practical bacteriology for some years to come.

## APPENDIX II.

### CHEMICAL LITERATURE FOR AUGUST, 1895.

Vol. I. No. 296. *American Journal of Science.* (August, 1895.)

*Gooch, F. A.,* and *Phelps, I. K.,* The Precipitation and Gravimetric Determination of Carbon Dioxide (pp. 101-104). *Kreider, D. A.,* Notes on Convenient Forms of Laboratory Apparatus (pp. 133-135).

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## APPENDIX I.

### NOTICES OF BOOKS.

*A Manual of Physiology. With Practical Exercises.* By G. N. Stewart, M.A., D.Sc., M.D. Edin., D.P.H. Camb., Professor of Physiology in the Western Reserve University, Cleveland. London : Baillière, Tindall & Cox, 1895.

Professor Stewart is to be congratulated on having written a book which will be useful alike to the beginner and to the advanced student.

Several of the Manuals of Physiology in use at the present time date from a period when the physiology taught in Medical schools was of a very meagre description, and as advances have been made and more thorough teaching has become necessary these manuals have been added to and amplified.

From this origin serious defects arise. The treatment of the subject lacks homogeneity, and except in those cases where whole chapters have been rewritten a sort of patchwork effect is produced, and a sense of dissatisfaction arises which often leads to the student neglecting his reading altogether.

Such defects as these are altogether avoided in those rare cases where an enthusiastic worker who possesses at once a power of clear description and lucid explanation and a thorough grasp of the subject in its latest developments can be persuaded to make use of his knowledge to smooth the way for beginners in his chosen science.

We have in the book before us an example of such a case. The author, besides being one of the most prominent of the younger generation of physiologists, has had a very considerable experience in training medical students and others in the paths of physiology, and of this experience he has taken full advantage in writing his book. Briefly, the plan adopted is that of providing at the end of each section of theoretical matter some pages of directions for practical exercises which shall illustrate the phenomena described. In this way a class of students may be taken through the theoretical and practical work together, to the great advantage of everybody concerned ; it often being the case at present either that the students do not understand the theoretical bearings of the practical work they are called upon to do, or that they fail to grasp the full significance of the book work because it is not fully illustrated by laboratory exercises. This must often be the case when the courses are conducted by two different teachers. Where the same man is teacher and lecturer things are at their best, and students have the best possible chance of learning their subject in a satisfactory manner, and where this is impossible the next best thing is for the theoretical and practical work to be selected by the same hand, and set forth in a manner to mutually illustrate each other.

Dr. Stewart has gone very thoroughly over the ground, and has not scrupled where necessary to introduce histological descriptions, *e.g.*, in describing absorption of fat by the epithelium of the villi, and the changes undergone by the cells of the salivary glands during activity.

On the other hand, general histology is excluded, and the 786 pages are devoted to legitimate physiology throughout.

The volume is brought well up to date, and gives evidence of having been written by one actively working at the subject. The plan of using two different types has been adopted, and will prove useful in defining portions which may with advantage be omitted in reading through the work a first time.

Defects there are and misprints, and some of the figures will appear rough to fastidious eyes, but many of us will recognise in these rough drawings a strong likeness to familiar pieces of apparatus with which, in the past, work which will live has been done.

The print and paper are excellent, and the coloured figures well selected and admirably reproduced.

*A Text-book of the Science and Art of Breadmaking.* By William Jago, F.I.C., F.C.S.  
London : Simpkin, Marshall, Hamilton, Kent & Co., Ltd., 1895.

In *The Science and Art of Breadmaking* Mr. Jago has given to the world a volume containing an immense amount of information on almost all subjects connected with bread-making.

Recognising that many of his readers would probably have but scanty scientific libraries to refer to, the author has prefaced the more serious parts of the work with some pages of elementary physical definitions and notes on the properties of the more important chemical elements and compounds. The construction and use of the microscope are shortly described, and then follow chapters in which the carbohydrates and proteids are adequately treated. The important subjects of Enzymes and Fermentation come in for a good share of attention and are treated in such a way as to be intelligible to any one who is likely to refer to the book. The plates in this section are numerous and useful.

In the chapters on breadmaking, bakehouse design, and flour testing, immense stores of information are laid bare, whilst the section on the cause of and cures for sour bread will be of service to many.

Altogether we expect the book will take its place as one of the most important works of reference in the hands of those connected with the baking trade.

*Leitfaden für histologische untersuchungen.* Von Dr. B. Rawitz. Zweite umgearbeitete und vermehrte auflage. Jena: Gustav Fischer, 1895.

This convenient little volume forms an excellent manual of histological technology. A very large number of fixing, hardening, and staining methods are described, and a useful chapter on microtomes and microtome knives is also included. The first part of the volume ends with a brief account of the process of reconstructing in wax the form and structural details observed in a series of sections. The second part deals with the practical application of the methods previously described, to the various tissues of different animals. The book is decidedly worthy of commendation, and the author's own notes and criticisms on the many processes described will be valuable to histologists.

The October number of the *Photogram* (London : Dawbarn & Ward) contains a useful note on Photographing Coins and Medals; good reproductions of Photographs of Maori types by A. Iles, of Thames, N.Z.; a continuation of Mr. Charles Gamble's papers on Gums, Resins, Balsams, Oils, and Waxes; and a specially welcome paragraph on the Photography of the Retina, besides other articles and notes.

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## APPENDIX II.

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*Matignon, C.*, et *Deligny*, Sur les substitutions nitrées (pp. 422-424). *Maquenne, L.*, Sur l'explosion des gaz endothermiques (pp. 424-427).

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*Malbot, H.* et *A.*, Recherches sur les phosphates d'Algérie. Cas d'une roche phosphatée de Bougie, présentant la composition d'un superphosphate (pp. 442-445).

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*Moissan, H.*, Sur un échantillon de carbon noir du Brésil (pp. 449-450). *Griffiths, A. B.*, et *Platt, C.*, Sur la composition de la pélagéine (pp. 451-452).

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*Faure, C.*, Sur un nouvel engrais azoté : le cyanate de calcium (p. 463). *Klobb, T.*, Synthèses au moyen de l'éther cyanacétique (pp. 463-465). *Béhal, A.*, Constitution des acides produits dans l'oxydation de l'acide campholénique inactif (pp. 465-468).

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*Denigès, G.*, Trois nouveaux réactifs des azotites (pp. 289-293). *Vaudin, L.*, Sur l'emploi du chromate de plomb pour colorer les pâtisseries communes (pp. 293-294). *André, C.*, Un nouvel anesthésique local : le gaïacol (pp. 294-298).

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**Band cxxxiii. Heft 6. Archiv der Pharmacie. (10th September, 1895.)**

*Partheil, A.*, Ueber die Bestimmung des Glycerins im Weine, etc. (pp. 391-398). *Winterstein, R.*, Chemische Zusammensetzung von Pachyma Cocos und Mylitta lapidescens (pp. 398-410). *Beckurts, H.*, Zur Kenntnis der Angostura-Alcaloide (pp. 410-423). *Beckurts, H.*, und *Seiler, H.*, Ueber Fettuntersuchungen mit dem Refractometer (pp. 423-429). *Beckurts, H.*, und *Oelze, F.*, Zur Kenntnis des Hirschtaigs (pp. 429-430). *Plugge, P. C.*, Ueber das Vorkommen von Cytisin in verschiedenen Papilionaceen (pp. 430-441). *Plugge, P. C.*, Ueber das Matrin, das Alcaloid der Sophora augustifolia (pp. 441-443). *Hallström, K. T.*, Anatomische Studien ueber den Samen der Myristicaceen und ihre Arillen (pp. 443-470).

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*Friedlander, P.*, und *Weisberger, J.*, Ueber einige parasubstituirte  $\alpha$ -Naphtoësäuren (pp. 1838-1843). *Von Norwall, K. F.*, Erwiderung (pp. 1843-1845). *Pechmann, H. v.*, und *Wedekind, E.*, Ueber das Aldol des Diacetils (pp. 1845-1847). *Pechmann, H. v.*, Ueber das Verhalten fetter Diazoerbindungen gegen schweflige Säure Alkalien (pp. 1847-1850). *Konowalow, M.*, Ueber eine empfindliche Reaction der primären und secundären Nitroverbindungen (pp. 1850-1852). *Konowalow, M.*, Nitirrende Wirkung der Salpetersäure auf den Charakter gesättigter Verbindungen besitzende Kohlenwasserstoffe und deren Derivate (pp. 1852-1866). *Erlenmeyer, E. Jun.*, Ueber Isodiphenyloxäthylamin, ein Condensations product von Benzaldehyd und Glycocoll (pp. 1866-1870). *Gassmann, C.*, und *Kraft, E.*, Ueber Eugenolderivate (pp. 1870-1872). *Knoll, R. J.*, und *Cohn, P.*, Ueber Naphthylindoxanen (pp. 1872-1874). *Sviriewski, V.*, Ueber Methylcarbonate einiger mehrwertigen Phenole (pp. 1874-1876). *Jakimowicz, P.*, Ueber die Darstellung von Thymolphthalid (pp. 1876-1877). *Pinner, A.*, Ueber die Addition von Brom zu Tetrolsäure (pp. 1877-1887). *Bamberger, E.*, und *Meimberg, F.*, Einige weitere Beobachtungen ueber Azofarbstoffe (pp. 1887-1897). *Söderbium, H. G.*, Ueber einige von Diphenoloxäthylamin sich ableitende heterocyclische Basen (pp. 1897-1904). *Pictet, A.*, und *Crépieux, P.*, Ueber Phenyl und Pyridyl-pyrrole und die Constitution des Nicotins (pp. 1904-1913). *Brühl, J. W.*, Ueber Esterifizierung und Verseifung (pp. 1913-1915). *Oddo, G.*, Ueber die constitution der Isonitrosoketone (pp. 1915-1917). *Salkowski, H.*, Ueber Esterbildung bei aromatischen Amidosäuren (pp. 1917-1923). *Le Bel, J. A.*, Zusatz zu H. P. Walden's Veröffentlichung ueber active Halogenverbindungen (pp. 1923-1925). *Widman, O.*, Ueber Phenyl und Tribromphenylazocarbonäsäure (pp. 1925-1932). *Pinner, A.*, Ueber Nicotin (pp. 1932-1935). *Fromm, E.*, Ueber geschwefelte Abkömlinge der Imidodicarbonsäure (pp. 1935-1940). *Cross, C. F.*, *Bevan, E. J.*, und *Smith, C.*, Ueber die Frage nach dem Ursprung ungesättigter Verbindungen in der Pflanze (pp. 1940-1946). *Friedlander, P.*, Untersuchungen ueber isomere Naphthalinderivate (pp. 1946-1954). *Brunn, E.*, Ueber Darstellung der drei Nitraniline (pp. 1954-1955). *Wallach, O.*, Ueber Isomeren innerhalb der Terpenreihe (pp. 1955-1968). *Kuhling, O.*, Ueber die Oxydation des Tolualloxazins II. (pp. 1968-1971). *Lippmann, Ed.*, Ueber das Apochinin und sein Drehungsvermögen (pp. 1971-1973). *Fischer, E.*, Ueber den Volemit, einen neuen Heptit (pp. 1973-1975). *Fischer, E.*, und *Fay, I. W.*, Ueber Idonsäure, Idose, Idit und Idozuckersäure (pp. 1975-1983). *Wislicenus, H.*, und *Kauffmann, L.*, Notiz ueber die Reactionen des amalgamirten Aluminiums (pp. 1983-1986). *Koenigs, W.*, Weitere Beiträge zur Kenntniss des Merochinens (pp. 1986-1991). *Ladenburg, A.*, Ueber Racemie und ueber Wärmestörungen beim Vermischen von Flüssigkeiten (pp. 1991-1995).

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W.*, Ueber ein optisch Actives Terpineol (pp. 2189-2191). *Tiemann, F.*, Ueber das Bromphenylhydrazen und Semicarbazone des d-Camphers (pp. 2191-2192). *Michaelis, A.*, und *Erdmann, G.*, Ueber die Thionylamine der Amidoazoverbindungen und der Naphthylendiamine (pp. 2192-2205). *Michaelis, A.*, und *Luxembourg, K.*, Ueber n-Phosphine und n-Phosphoniumverbindungen (pp. 2205-2212). *Michaelis, A.*, und *Kuhlmann, F.*, Ueber Tollyl- und Phenylanil-phosphoniumverbindungen (pp. 2212-2217). *Töhl, A.*, Spaltung des Thiophens durch Piperidin (pp. 2217-2220). *Stoerner, R.*, und *Dziemski, O.*, Ueber einige disubstituierte Amidoacetone (pp. 2220-2227). *Krämmel, H.*, Ueber die Einwirkung von Halogenen und Thiophosgen auf Amidoxime (pp. 2227-2234). *Will, W.*, Naphtazarin aus  $\delta$ -Tetranitronaphthalin (1.2.5.8.) 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*Bourgeois, E.*, Ueber die Einwirkung der Monobromderivate der aromatischen Kohlenwasserstoffe auf die Bleimercaptide (pp. 2312-2331).

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*Curtius, T.*, Ueber Benzazid und einige Säureazide der Fettereihe (pp. 210-227). *Sruwe, A.*, und *Radenshausen, R.*, Ueber Azide substituirter Benzösäuren (pp. 227-243).  
*Curtius, T.*, Das Hydrazid und Azid der Hippursäure (pp. 243-272). *Curtius, T.*, Zusätze und Berichtigungen (pp. 272-277). *Tecla, N.*, Zur Bestimmung der chemischen Attraktionsgeschwindigkeit (pp. 277-284). *Vaibel, W.*, Ueber die bei der Bildung von Azofarbstoffen sich zeigenden Gesetzmässigkeiten (pp. 284-288).

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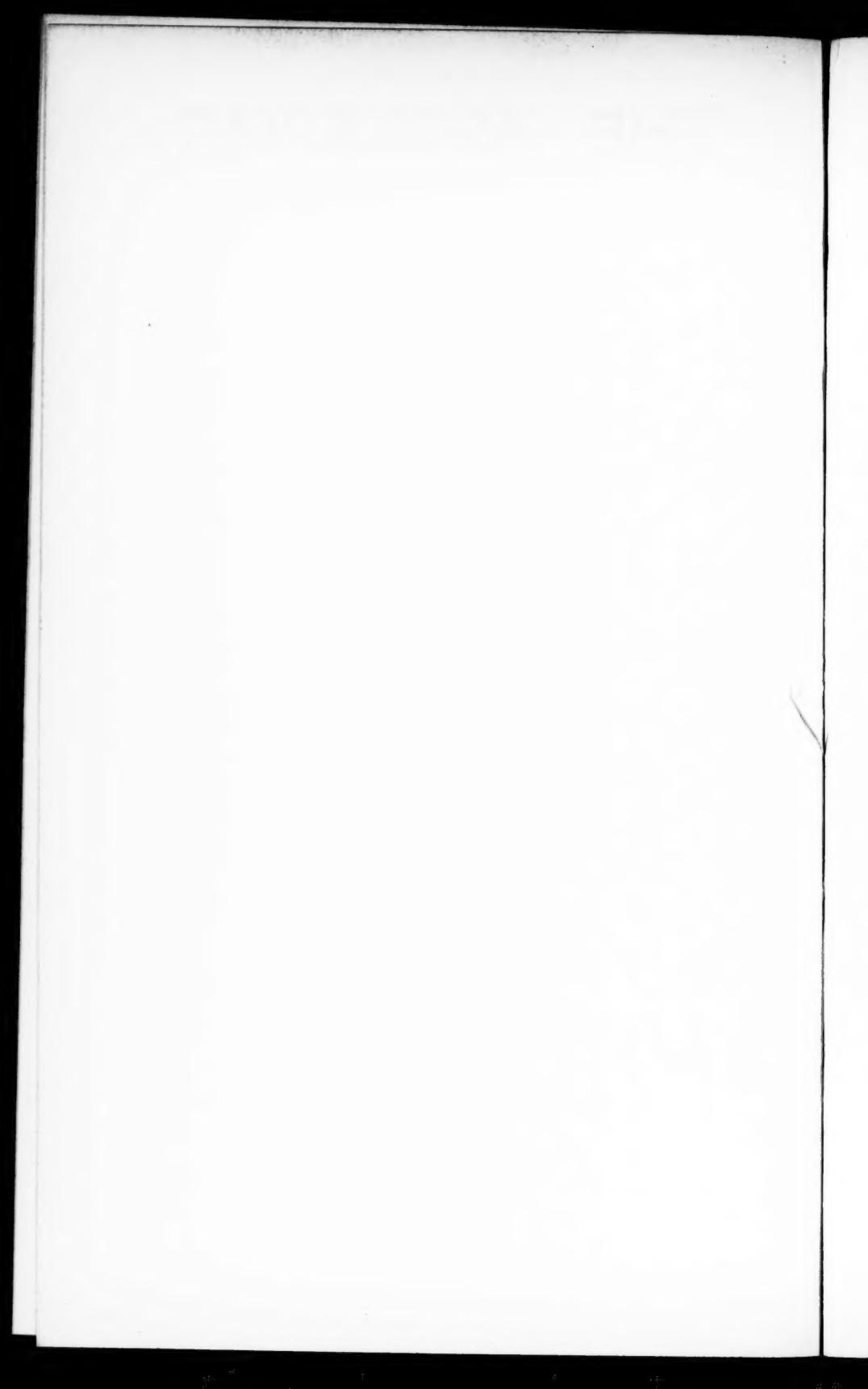
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*Richards, T. W.*, und *Rogers, E. F.*, Neubestimmung des Atomgewichtes von Zink (pp. 1-25). *Arctowski, H.*, Notiz ueber die Krystallisation des Broms (pp. 25-27). *Arctowski, H.*, Zur Krystallographie des Quecksilberchlorids (pp. 27-31). *Kruss, G.* und *H.*, Eine neue Methode der quantitativen spektralanalyse (pp. 31-44). *Lorenz, R.*, Ueber die Darstellung von Zinntrichlorid in grossen Quantitäten (pp. 44-47). *Vandenbergh, A.*, Ueber Molybdandihydroxychlorid (pp. 47-60). *Neubauer, H.*, Ueber Phosphorsäurebestimmung nach der Molybdän-methode (pp. 60-66). *Marchetti, G.*, Studium einiger Fluoride und Oxyfluoride des Kaliums (pp. 66-74). *Lorenz, R.*, Ueber die Umwandlung von Chlor in Salzsäure (pp. 74-78). *Lorenz, R.*, Versuche zur Begründung eines gemeinsamen elektrolytischen Zink und Bleigewinnungsverfahrens (pp. 78-117). *Clever, A.*, und *Muthmann, W.*, Zur Kenntnis der Verbindungen des Selens mit dem Arsen (pp. 117-148). *Schulze, J.*, Ueber einige Salze der Chrom- und Bichrom-säure mit den Schwermetallen (pp. 148-155). *Thomsen, J.*, Ueber die Farbe der Ionen als Funktion der Atomgewichte (p. 155).

**Anno xxv. Vol. 2. Fascicolo 2. *Gazzetta Chimica Italiana.* (18th Sept., 1895.)**

*Schiff, R.*, e *Prosio, P.*, Sulla sintesi di derivati della piridina per l'azione dell'etere acetacetico sulle aldeidi in presenza di ammoniaca (pp. 65-91). *Ampola, G.*, e *Manuelli, C.*, Il bromoformio in crioscopia (pp. 97-107). *Oddo, G.*, e *Mansella, E.*, Ricerche su alcuni cementi italiani ed esteri (pp. 101-113). *Oddo, G.*, e *Mansella, E.*, Ricerche sui fenomeni che avvengono durante la presa dei cementi (pp. 113-127). *Anderlini, F.*, Sopra alcune questioni relative alla rifrazione atomica del' issigeno (pp. 127-162). *Angeli, A.*, e *Rimini, E.*, Sopra alcuni bromoderivati della serie della canfira (pp. 162-164).



## APPENDIX I.

### NOTICES OF BOOKS.

*The Flowering Plants of Western India.* By Rev. Alexander Kyd Nairne. London: W. H. Allen & Co.

Although Mr. Nairne has brought together a large number of interesting facts concerning the plants of Western India, there is evidence on almost every page of his little book of his incompetence for the task which he has attempted. Indeed the botany is beyond serious criticism, and the extracts from a great variety of books relating to the properties, uses, and distribution of the plants were evidently not made by a person sufficiently acquainted with the subject to exercise any sort of discrimination.

*An Introduction to Chemical Crystallography.* By Andreas Fock. Translated and edited by William J. Pope. Oxford: The Clarendon Press, 1895.

This small book of 184 pages is intended to supply the student with such of the important truths of crystallography as are of especial service in the study of chemical problems. Of course it is impossible within the limits of so small a volume to deal exhaustively with the various divisions of the subject, and occasionally the treatment is far from adequate. This is particularly evident in the chapters dealing with the nature of crystals and the laws of crystallisation, and again in the chapter on solution, which is the most superficial in the book. On the other hand the book contains much that is excellent. It is significant that the work of Willard Gibbs finds a place—work of such importance to the chemist and so long overlooked by him, no doubt on account of its generality. Rozzeboom's development of the analogy between the solubility of mixed crystals and the evaporation of mixed liquids is also treated with sufficient fulness to give the reader an idea of its scope and importance. The chapters on double salts, isomorphism, physical isomerism, and the relations between crystalline form and chemical composition are particularly good, and contain much having the most direct bearing on chemistry.

On discovering a new substance nothing delights the heart of the chemist more than to obtain it in well-defined crystals, yet when he obtains his heart's desire after analysing the substance he, in general, determines its melting-point, and considers that the determination of other physical properties is unnecessary. The shortsightedness of this policy is clearly brought home by numerous instances of substances having several melting-points varying with their crystalline condition, and the suggestion made in the translator's preface that observations in the polarising microscope should always be made with new crystalline substances merits the attention of all workers in this field of chemical research.

The book would be improved by the addition of a chapter dealing with the crystallographic terms used—axial ratios, mass-points, etc.—many of which are not familiar to the chemist. Nevertheless the book may, on the whole, be recommended as giving a brief and interesting historical account of the nature, origin, preparation, and properties of crystals.

## APPENDIX II.

### CHEMICAL LITERATURE FOR OCTOBER, 1895.

Vol. I. No. 299. *American Journal of Science*. (November, 1895.)

- Palmer, A. D. F.*, Wave Length of the D<sub>3</sub> Helium Line (pp. 357-359). *Hill, E. A.*, Additional Notes on Argon and Helium (pp. 359-377). *Wells, H. L.*, and *Hurlburt, E. B.*, Ammonium-Cuprous Double Halogen Salts (pp. 390-394). *Gooch, F. A.*, and *Evans, P. S.*, Reduction of Selenic Acid by Hydrochloric Acid (pp. 400-402). *Gooch, F. A.*, and *Scoville, W. S.*, Reduction of Selenic Acid by Potassium Bromide in Acid Solution (pp. 402-405).

Vol. xvii. No. 10. *Journal of the American Chemical Society*. (October, 1895.)

- Blair, A. A.*, and *Whitfield, J. E.*, Ammonium Phosphomolybdate and the Reducing Action of Zinc in the Reducto (pp. 747-760). *Rosell, C. A. O.*, The Ferrates (pp. 760-769). *Beeson, J. L.*, A Simple and Convenient Apparatus for Estimating the Water-holding power of Soils (pp. 769-771). *Gill, A. H.*, A Modification of Hinman's Explosion Pipette (pp. 771-772). *Lunge, W.*, Estimation of Sulphur in Pyrites (pp. 772-775). *Prescott, A. B.*, The Periodides (pp. 775-781). *Dunnington, F. P.*, An Improved Gas Regulator (pp. 781-783). *Munroe, C. E.*, Inspection of Cotton for Use in the Manufacture of Gun-cotton (pp. 783-789). *Fleck, H.*, and *Bassett, L. L.*, Reduction with Magnesium Amalgam (pp. 789-791). *De Benneville, J. S.*, Two Definite Carbides of Iron with Chromium (Molybdenum and Tungsten) (pp. 791-801). *Phillips, F. C.*, On the Possibility of the Occurrence of Hydrogen and Methane in the Atmosphere (pp. 801-809). *Harris, E. O.*, A New Generator (pp. 809-811). *Krug, W. H.*, The Determination of Tannin by Metallic Oxides (pp. 811-814). *Heath, G. L.*, The Estimation of Sulphur in Refined Copper (pp. 814-822). *Kehler, L. F.*, Acidimetric Estimation of Vegetable Alkaloids (pp. 822-832).

Vol. xvii. No. 11. (November, 1895.)

- Williams, R. P.*, An Electrolytic Process for the Manufacture of White Lead (pp. 835-842). *Venable, F. P.*, The Chlorides of Zirconium (pp. 842-843). *Noyes, W. A.*, *McTaggart, J. R.*, and *Craver, H. W.*, The determination of the Heating Effects of Coal (pp. 843-849). *Whitehead, C.*, Tellurium; Its separation from Copper Residues, with Notes on some New Reactions (pp. 849-855). *Noyes, W. A.*, and *Dorrance, J. T.*, The Electrolytic Reduction of paramitro Compounds in Sulphuric Acid Solution (pp. 855-859). *Prescott, A. B.*, and *Treabridge, O. F.*, Periodides of Pyridine (pp. 859-869). *Andrews, L.*, On the Analysis of Alloys of Lead, Tin, Antimony, and Arsenic (pp. 869-873). *Shimer, P. W.*, The Determination of Graphite in Pig Iron (pp. 873-877). *Griffith, A. B.*, and *Platt, C.*, On the Composition of Pelagite (pp. 877-878). *Wells, H. L.*, and *Mitchell, W. L.*, On the Volumetric Determination of Titanic Acid and Iron in Ores (pp. 878-883). *Barton, G. E.*, Arsenic in Glycerol (pp. 883-890). *Noyes, W. A.*, and *Watkins, W. H.*, The Occurrence of Trimethylene Glycol as a By-Product in the Glycerol Manufacture (pp. 890-891). *Phillips, F. C.*, The Evolution Method for the Determination of Sulphur in White Cast Iron (pp. 891-901). *Cushman, A. S.*, and *Hayes-Campbell, J.*, On the Volumetric Determination of Lead (pp. 901-904). *Baskerville, C.*, Reaction between Copper and Concentrated Sulphuric Acid (pp. 904-912).

Vol. xvii. No. 8. *American Chemical Journal*. (October, 1895.)

- White, J.*, On Sulphonphthalins and some Related Compounds (pp. 545-556). *Jones, W.*, Sulphonphthalain derived from Orthosulphoparatolic Acid (pp. 556-570). *Miller, A. S.*, A Study of the Chemical Behaviour of Ammonia toward Ferric Chloride and Ferrous Chloride (pp. 570-579). *Jackson, C. L.*, and *Grindley, H. S.*, Action of Soda Alcoholate on Chloramyl. Acetal Derived from Substituted Quinines (pp. 579-607). *Mead, J. L.*, and *Kremers, E.*, From Pinene to Carvacrol (pp. 607-612). *Wheeler, H. L.*, On Halogen Addition Products of the Anilides (pp. 612-620). *Noyes, W. A.*, and *Ellis, R. M.*, Synthesis of Diphenylbiphenyl and its Identification as Benzylthrene (pp. 620-622).

Vol. xx. No. 235. *The Analyst.* (October, 1895.)

*Richmond, H. D.*, Duclaux's Method for the Estimation of "Volatile Fatty Acids," the Laws Governing "Volatility" deduced therefrom, their Application to Analysis, more Especially of Butter (concluded) (pp. 217-220).

Vol. lxvii. No. 396. *Journal of the Chemical Society.* (November, 1895.)

*Chikashige, M.*, Mercury Perchlorates (pp. 1013-1018). *Luxmoore, C. M.*,  $\alpha$ -Ethylene-Dihydroxylamine Dihydrobromide (pp. 1018-1019). *Luxmoore, C. M.*, Alleged Isomerism of Potassium Nitrosousulphate (pp. 1019-1024). *Heycock, C. T.*, and *Neville, F. H.*, On the Freezing Points of Gold and Silver (pp. 1024-1030).

Vol. xiv. No. 10. *Journal of the Society of Chemical Industry.* (31st Oct., 1895.)

*Briggs, T. L.*, Note on the Manufacture of Phenylamidoazobenzene and some Derivatives (pp. 851-852). *Schweitzer, H.*, Adulteration and Substitution of Drugs (pp. 852-853).

Vol. xl. No. 246. *Philosophical Magazine and Journal of Science.*  
(November, 1895.)

*Lehfeldt, R. A.*, On the Properties of a Mixture of Liquids (pp. 397-413). *Waterman, F. A.*, An Improved Calorimeter for the Application of the Method of Mixtures (pp. 413-421). *Sutherland, W.*, The Viscosity of Mixed Gases (pp. 421-431). *Estreicher, T.*, On the Pressures of Saturation of Oxygen (pp. 454-463). *Wilde, H.*, On Helium and its place in the Natural Classification of Elementary Substances (pp. 466-472). *Pickering, S. U.*, Self-recorded breaks in the Properties of Solutions (pp. 472-476).

Series 7. Tome v. *Annales de Chimie et de Physique.* (November, 1895.)

*Maneuvrier, G.*, Nouvelle méthode de détermination du rapport  $\frac{C}{c}$  pour l'air et d'autres gaz (pp. 321-377). *Denigré, G.*, Sur une nouvelle méthode cyanimétrique et sur les applications qui en dérivent (pp. 377-428). *Moissan, H.*, Sur le dosage du bore (pp. 428-432).

Tomes xiii.-xiv. Nos. 20-21. *Bulletin de la Société Chimique de Paris.*  
(5th November, 1895.)

*De Gramont, A.*, Sur l'analyse spectrale directe des composés solides et plus spécialement des minéraux (pp. 945-947). *Thomas, V.*, Action de l'oxyde nitrique sur le chlorure ferreux (pp. 947-953). *Moissan et Charpy, G.*, Sur l'acier au bore (pp. 953-956). *Moissan, H.*, Préparation et propriétés du borure de fer (pp. 956-959). *Moissan, H.*, Préparation et propriétés du titane (pp. 959-966). *Moissan, H.*, Préparation et propriétés du molybdène pur fondu (pp. 966-972). *Moissan, H.*, Réduction de la silice par le charbon (pp. 972-973). *Moissan, H.*, Action du fluor sur l'argon (pp. 973-975). *Perrot, L.*, Dissociation du chlorure de zinc par l'eau (pp. 975-979). *Bayrac, H. P.*, Sur une nouvelle quinone "La paracycloquinone" (pp. 979-980). *Bayrac, H. P.*, Sur la préparation de l'orthoisopropylphénol et du métapropylphénol de Jacobsen (pp. 981-984). *Bayrac, H. P.*, Sur une nouvelle quinone "l'isopropylbenzoquinone". Constitution du métapropylphénol de Jacobsen (pp. 984-985).

Tome cxxi. No. 15. *Comptes Rendus hebdomadaires de l'Académie des Sciences.*  
(7th October, 1895.)

*Moissan, H.*, Etude de quelques météorites (pp. 483-486). *Charpy, G.*, Sur les propriétés mécaniques des alliages de cuivre et de zinc (pp. 494-496). *Lebeau, P.*, Sur un carbure de glucinium (pp. 496-499). *Varet, R.*, Recherches sur les combinaisons du cyanure de mercure avec les iodures (pp. 499-501). *Varet, R.*, Sur les doubles décompositions entre le cyanure de mercure et les sels des métaux alcalins et alcalinoterreux (pp. 501-502).

Tome cxxi. No. 16. (14th October, 1895.)

*Schloesing, T.*, Sur le dosage de l'argon (pp. 525-528). *Engel, R.*, Sur l'action de l'acide chlorhydrique sur le cuivre (pp. 528-530). *Astre, C.*, Action de la potasse et de l'éthylate de potassium sur la benzoquinone (pp. 530-532). *Patein, G.*, et *Dufau, E.*, Des combinaisons de l'antipyrine avec les diphenols: influence des positions respectives des oxydryles (pp. 532-535). *Nastukoff*, Essais sur le pouvoir réducteur des levures pures; moyens de les mesurer (pp. 535-536).

Tome cxxi. No. 17. (21st October, 1895.)

*Moissan, H.*, Etude du graphite extrait d'une pegmatite (pp. 538-540). *Moissan, H.*, Etude de quelques variétés de graphite (pp. 540-542). *Louguinine*, Etude sur les chaleurs

latentes de vaporisation des acétones de la série grasse, de l'octane, du décané, et de deux éthers de l'acide carbonique (pp. 556-559). *Astre, C.*, Dérivés potassiques peroxydés de la benzoquinone (pp. 559-561). *Balland*, Sur la composition des riz importés en France (pp. 561-564). *Gréhant, N.*, Sur la toxicité de l'acetylène (pp. 564-566).

Tome cxxi. No. 18. (28th October, 1895.)

*Margoty*, Sur les équivalents chimiques (pp. 591-594). *Varet, R.*, Recherches sur les cyanures de lithium, de magnésium, de cuivre (pp. 598-600). *Henry, L.*, A propos du carbure de glucinium (pp. 600-601). *Lebeau, P.*, Sur l'analyse de l'emeraude (pp. 601-604). *Schloesing, T.*, Sur le dosage de l'argon (pp. 604-607). *Burker, E.*, Formation synthétique d'un nouvel acide cétonique (pp. 607-610).

Tome cxxi. No. 19. (4th November, 1895.)

*Moissan, H.*, Action du silicium sur le fer, le chrome et l'argent (pp. 621-626). *Lebeau, P.*, Sur le traitement de l'emeraude et la préparation de la glucine pure (pp. 641-644). *Parmentier, F.*, Sur un groupe d'eaux minérale renfermant de l'ammoniaque: eaux bitumineuses (p. 644). *Manceau, E.*, Sur le dosage du tannin dans les vins (pp. 646-648). *Brochet, A.*, Action du chlore sur l'alcool propylque normal (pp. 648-651). *Renard, A.*, Sur l'azotoluène (pp. 651-652). *Konowaloff*, Etude de la nitration du menthone (pp. 652-653). *Omeliansky, V.*, Sur la fermentation de la cellulose (pp. 653-655).

15<sup>e</sup> Année. Tome ii. No 8. *Journal de Pharmacie et de Chimie.*

(15th October, 1895.)

*Jungfleisch*, Louis Pasteur (pp. 337-342). *Vaudin, L.*, Sur la migration du phosphate de chaux dans les plantes (pp. 342-344). *Mallat, A.*, Échelle alcaline des eaux minérales naturelles du bassin de Vichy (pp. 344-345). *Barthe, L.*, Sur le dosage de l'acide borique (pp. 345-347).

15<sup>e</sup> Année. Tome ii. No. 9. (1st November, 1895.)

*Bourquelot, E.*, Sur la volémite, nouvelle matière sucrée (pp. 385-390). *Fischer, E.*, Sur la volémite, nouvelle heptite (pp. 390-392). *Balland*, Sur les ustensiles en aluminium (pp. 392-396). *Meillre, G.*, Préparation des résidus secs ou extraits à basse température dans l'analyse des liquides altérables; sang, lait, urine, liquides fermentés, etc. (pp. 396-400). *Denigès, G.*, Sur une réaction colorée spécifique des chlorates (pp. 400-402). *Patein, G.*, et *Dufou, E.*, Des combinaisons de l'antipyrine avec les diphenols: influence des positions respectives des oxydryles (pp. 402-405).

Tome xxvii. No. 6. *Journal de la Société Physico-chimique Russe.*

*P. Kritschchenko, Pissarjewsky, Gerschkowitsch, et Efrussi*, De l'influence de la substitution sur la marche des réactions cétones: I. Action du pentachlorure de phosphore sur les éthers acétodiacarboniques substitués. II. Action du phénylhydrazine sur les éthers acétodiacarboniques (pp. 327-335). *Krasusky, A.*, Sur le chloronitrobenzyle et le tétranitrostilbène (pp. 335-342). *Dobrohotoff, W.*, Sur la vitesse de formation des éthers acétiques de quelques alcools cycliques (pp. 342-347). *Ipatieff, W.*, Action du brome sur les alcools tertiaires (pp. 347-376). *Poehl, A.*, Sur une substance colorante de l'urine. *Gerschkowitsch*, Sur l'argon. *Lidoff, A.*, Sur la composition de la mine d'asphalte de Kertsch. *Schakaletoff, W.*, Sur l'identité de l'acide abiétique et de l'acide silvique. *Konowaloff, M.*, Action nitrifiante de l'acide nitrique sur les hydrocarbures aliphatisques et leurs dérivés. *Konowaloff, M.*, Une réaction sensible pour reconnaître les composés nitrés primaires et secondaires. *Konowaloff, M.*, Sur les phénomènes de l'isométrie ayant lieu lors de la synthèse des hydrocarbures aromatiques, par la méthode Friedel-Crafts. *Konowaloff, M.*, Données concernant le pouvoir refringent des combinaisons azotées. *Ichernik*, Analyse de l'or natif du district de Batoum (pp. 376-386).

Band cclxxxviii. Heft 2. *Justus Liebig's Annalen der Chemie.*

(21st October, 1895.)

*Fisher, E.*, Ueber Kohlenstoffreichen Zucker aus Galactose (pp. 139-157). *Fisher, E.*, und *Ach, L.*, Ueber einige schwefelhaltige Verbindungen der Harnsäuregruppe (pp. 157-176). *Fittig, R.*, und *Wolff, A.*, I. Ueber die Isopropylglutolactonsäure und die Constitution der Terpenylsäure (pp. 176-192). *Lesser, R.*, II. Ueber die Einwirkung von Natriumäthylat auf das Phenylbutyrolacton (pp. 192-203). *Shields, J.*, III. Ueber die Reductions products des Phenylbutyrolactons und der Phenylparaconsäure (pp. 203-209). *Schunck,*

- E., und Marchlewski, L., Zur Chemie des Chlorophylls III. (pp. 209-218). Duden, P., und Scharff, M., Ueber die Constitution des Hexamethylentetramins (pp. 218-253). Philips, A., Untersuchungen in der Pyridinreihe (pp. 253-265).*
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und der Seifen in Gegenwart von Wasser. IV. Die Seifen als Colloide (pp. 2573-2583). *Krafft, F.*, und *Dyes, W. A.*, Ueber Destillationen mit der continuirlich wirkenden Quecksilberluftpumpe (pp. 2583-2589). *Krafft, F.*, Ueber constant siedende und krystallisirbare Gährungsmilchsäure (pp. 2589-2597). *Hill, H. B.*, und *Torrax, J.*, Ueber die Bildung von s-Trinitrobenzol und p-Nitrophenol aus Nitromalon-Säurealdehyd (pp. 2597-2599). *Thiele, J.*, Ueber Phenylazocarbonamid und carbonsäure (pp. 2599-2601). *Thiele, J.*, Heizvorrichtung für Trockenkästen (pp. 2601-2602).

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unter denen das Wasserstoffsperoxyd sich zersetzt (pp. 161-178). *Mond, L., Ramsay, W., und Shields, J.*, Ueber die Occlusion von Sauerstoff und Wasserstoff durch Platin schwarz (pp. 178-181). *Wells, H. L., und Boltwood, B. B.*, Ueber Doppelsalze des Cäsiumchlorids mit Chromtrichlorid und Uranylchlorid (pp. 181-183). *Spring, W.*, Ueber ein Hydrat des Arsentrisulfids und seine Zersetzung durch Druck (pp. 185-189). *Staudenmaier, L.*, Untersuchungen ueber das Tellur (pp. 189-222). *Brunck, O.*, Ueber Ozonbildung (pp. 222-248). *Gooch, F. A., und Reynolds, W. G.*, Die Reduktion der selenigen Säure und Selensäure durch Jodwasserstoffsäure (pp. 248-253). *Gooch, F. A., und Evans, P. S.*, Ueber die Reduktion der Selensäure durch Salzsäure (pp. 253-256). *Gooch, F. A., und Scoville, W. S.*, Ueber die Reduktion der Selensäure durch Bromkalium in saurer Lösung (pp. 256-259). *Hofmann, K. A.*, Ein explosives Doppelsalz von Cyankalium mit Kaliumnitrit (pp. 259-262). *Hofmann, K. A.*, Ueber das Nitroprussid-natrium (pp. 262-277). *Kreider, D. A.*, Ueber die quantitative Bestimmung der Perchlorate (pp. 277-289). *Langlet, N. A.*, Ueber das Atomgewicht des Helium (pp. 289-293).

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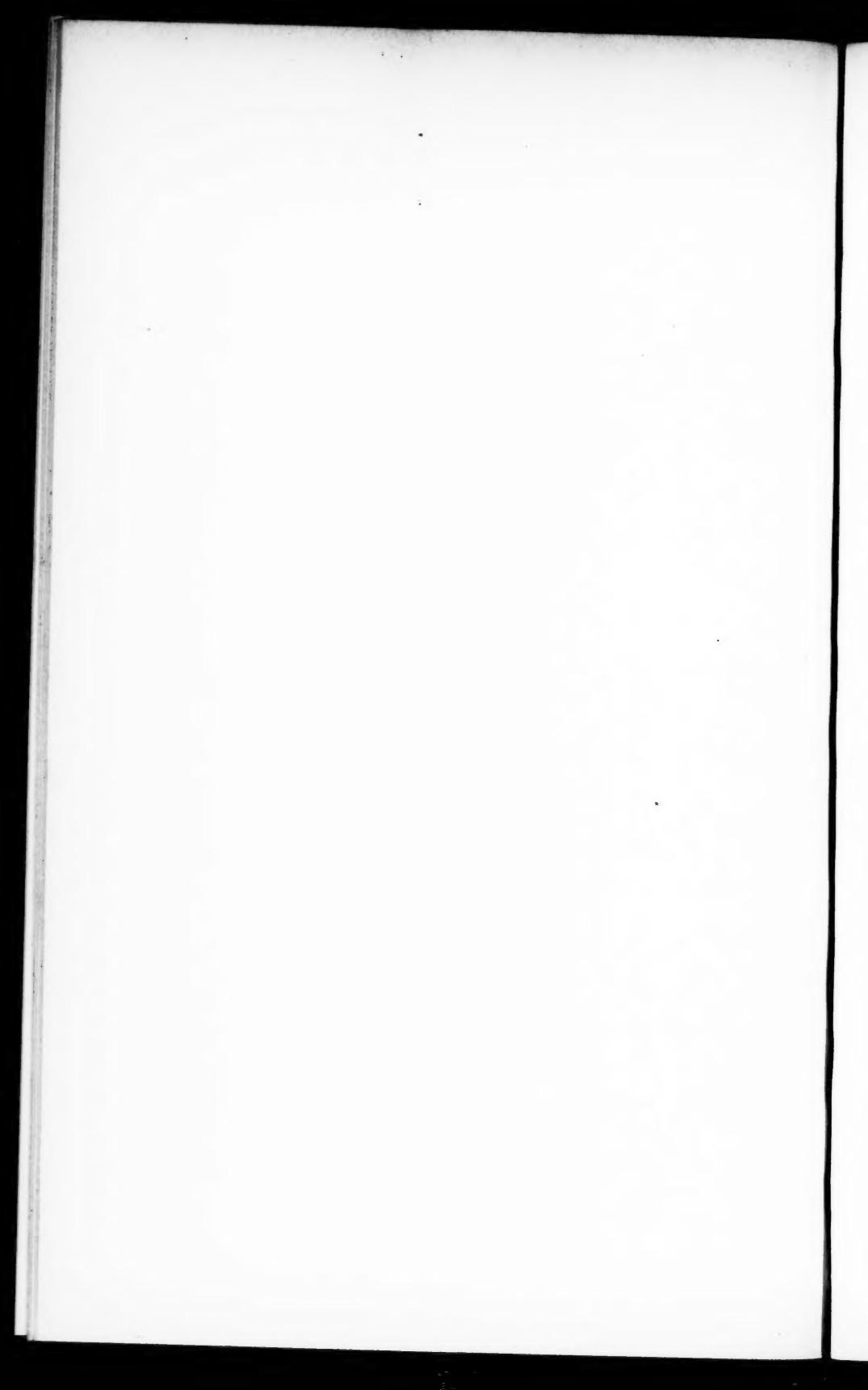
*Gordon, V.*, Ueber die Absorption des Stickoxyduls in Wasser und in Salzlösungen (pp. 1-17). *Tower, O. F.*, Studien ueber Superoxyd-Elektroden (pp. 17-51). *Garelli, F.*, Ueber den Einfluss der chemischen Konstitution organischer Stoffe auf ihre Fähigkeit feste Lösungen zu bilden. II. (pp. 51-61). *Cohen, E.*, Die Loslichkeit der Silberhalogenalts in verschiedenen Lösungsmitteln und ein dabei auftretendes Gleichgewicht. I. (pp. 61-70). *Löwenherz, R.*, Die Schmelzpunktserniedrigung des Glaubersalzes durch Zusatz von Fremdkörpern (pp. 70-91). *Lehmann, O.*, Ueber das Zusammenfliessen und Ausheilen flüssig-weicher Krystalle (pp. 91-97). *Lehmann, O.*, Ueber den Durchgang der Elektrizität durch Gase (pp. 97-118). *Noyes, A. A.*, Beitrag zur Kenntnis der Gesetze der Geschwindigkeit von polymolekularen Reaktionen (pp. 118-133). *Matty, M. E.*, Methode zur Bestimmung grosser elektrolytischer Widerstände (pp. 133-159). *Ostwald, W.*, Ueber rotes und gelbes Quecksilberoxid (pp. 159-161). *Kerster, F. W.*, Ueber den Verlauf einer umkehrbaren Reaktion erster Ordnung in homogenem System (pp. 161-180). *Baur, A. E.*, Bestimmung von Umwandlungspunkten auf elektrischem Wege (pp. 180-183). *Baur, A. E.*, Bestimmungen einiger Leitfähigkeiten (pp. 183-189).

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## APPENDIX I.

### NOTICES OF BOOKS.

*Die Leitungsbahnen in Gehirn und Rückenmark.* By W. von Bechterew, Professor in the University of Kasan. 8vo, pp. 210, with sixteen figures and a lithographed plate.

This is the authorised German version of a Russian treatise, mainly anatomical but partly physiological, dealing with the central nervous system. The translator is studying medicine at the Russian University of Dorpat. The author is the well-known neurologist and physician, recently promoted from Kasan to St. Petersburg.

The work consists of a clear if somewhat arbitrary statement of the anatomy of the human brain and spinal cord, as far as these are elucidated by the older methods of dissection, maceration, etc., assisted by the microscope, and especially as amplified by what is known as the Flechsig-Weigert method. Professor Bechterew has himself been an assiduous worker by this method, and has contributed a number of details to cerebral anatomy by its means; indeed the chief value of the volume before us is the outcome of this fact; and so preponderantly is the book compiled from the results obtained by this one method that it may be desirable in reviewing its pages to briefly recall the origin and principle on which the method is based.

The brain and spinal cord consist structurally of two kinds of anatomical substance, called from their tints respectively "grey matter" and "white matter". The nervous elements of the latter are without exception bundles of nerve fibres, to the fatty sheaths of which the opacity and milky appearance of the white matter is wholly due. That observant physiologist, the late Carl Ludwig, noted in the year 1872 that in the brain and spinal cord of new-born animals certain areas of the white matter are scarcely at all distinguishable from the grey matter. The want of whiteness in these areas proved, he found, to be due to the majority of the nerve fibres not having there at that early period of growth formed around themselves the sheathes of fat which they come later to possess. In this way originated the discovery that the nerve fibres of brain and spinal cord do not all develop together and at the same time and rate. Certain of them are late, certain of them earlier; and they develop in groups, late groups and early groups; and the grouping is determined strictly by function, fibres of identical function being developed contemporaneously.

The difference between certain groups or bundles in their date of acquirement of the fatty sheath is very great indeed. In the human embryo some nerve bundles are completely sheathed at half-term, others are not so even in children just old enough to walk. By following out these differences between sets of nerve fibres it is possible to trace the course of strands of them along the intricacies of the central nervous system; the method is much facilitated by use of dyes which stain deeply the fully-formed sheaths of the fibres, and leave the undeveloped sheath uncoloured. A remarkably successful method of dyeing for this purpose was devised by Weigert in 1883.

Ludwig put his discovery into the hands of his laboratory assistant, Paul Flechsig, and by the latter the anatomy of new important paths of conduction was made out in the years 1873-75, and published in a monograph. This research at once established Flechsig's fame, and led to his appointment as Professor of Psychotribe in Leipzig. Even Flechsig's labours had not exhausted the new field of observation, and many details remained over for others to undertake. With several of these Bechterew occupied himself in Flechsig's laboratory in 1884-85. From this period arises the volume now under consideration.

The book is certainly an interesting one, but is at the same time disappointing. It bears many marks of having been written not at leisure, but rather in spite of the want of it.

Among the references not a few are erroneous; this is markedly the case with those from English sources (*cf. pp. 25, 34, 201, etc.*). Again it is remarkable that neither in the preface nor in the description of the methods introduced by Ludwig is Ludwig's name referred to. Again, the author, although he bases his dicta almost exclusively on Ludwig's developmental method, has not sufficiently considered the limits of delicacy and accuracy of that method: he does not bear in mind that although the method can trace with accuracy the course of compact bundles of fibres, it is of little use in tracing scattered sets of fibres from

one part of the brain to another. Further, and this is the chief defect of the volume, the author seems very imperfectly acquainted with the wide harvest of facts gathered in recent years by the delicate method of Wallerian degeneration. Such errors as occur in his description on pp. 16 and 17, for instance, are due to want of acquaintance with the Wallerian results. Finally, Professor Bechterew does not appear to have grasped the difference existing between atrophic degeneration (or the secondary atrophy of Gudden) and the Wallerian degeneration. The phenomena are fundamentally and absolutely distinct. The latter process is confined to the actual nerve cell upon which the lesion (mechanical injury or what not) is inflicted; in the former phenomenon the field occupied is a whole physiological chain, or at least several links of a chain of functionally connected nerve cells.

When the work reaches, as we hope it may, a second edition, the author should bring it thoroughly up to date; the more so that in his preface he expresses his purpose in issuing the work to consist chiefly in the furnishing to busy students and practitioners a comprehensive account of the "Gegenwärtige Stand der Frage über die Leitungsbahnen des Hirns und mindestens den grössten Zeit der in dieser Hinsicht bekannten Thatsachen".

The figures in the text are very good, though very schematic. Several of them are original.

*Movement.* By E. J. Mary, Member of the Institute and of the Academy of Medicine, Professor at the College of France, Director of the Physiological Station. Translated by Eric Pritchard, M.A., M.B., B.Ch. (Oxon.). London: William Heinemann, 1895.

The advances made in photography during the last few years have been very great, and in no direction have these advances been more remarkable than in the representation of movements which take place too rapidly to be followed by the unassisted eye. Professor Boys' photographs of flying projectiles, Dr. Worthington's of the splash of a drop, and others are illustrations of this. The visit of Mr. Muybridge to England some years ago and the exhibition of the results he had obtained by means of his ingenious apparatus brought prominently to the notice of the public, scientific and otherwise, the great strides which had been made in the analysis by means of photography of animal locomotion, and the appearance of Mary's book in France showed that considerable attention was being given to the subject in that country also.

Unfortunately in England the amateur photographer, to whom we owe almost all the advances that have been made in photography in recent years, is, as a rule, almost entirely ignorant of scientific matters outside his own subject, and therefore much talent is wasted for want of a definite object to follow out. It is therefore a subject for congratulation that a translation of Mary's work has appeared, and that it is well calculated to appeal to unscientific readers. In Mary's *Movement*, as in so many French scientific works, the style is admirably clear, and the explanations of even complicated pieces of apparatus such as to be easily understood. The scope of the work is wide—indeed it forms a good summary of the whole subject of the representation of movement by the graphic method assisted by photography. The measurement of space and time is treated in the preliminary chapters, and later on the application of these measurements and the assistance rendered by photography in such application to the elucidation of problems in movements of animate and inanimate objects. Locomotion in man, in quadrupeds, in fish, birds and insects is thus analysed.

In the case of the complicated rhythms of the locomotion of quadrupeds some difficulty is usually experienced in understanding the sequence of events, and it is therefore advisable to use every means in our power to render the representation of such movement as simple as possible. In some of the figures of horses in motion (e.g., fig. 7, p. 9) it would have been simpler to have arranged the graphic records to read in the same direction as the horse is travelling in the figure, and in any case some indication should be given of the direction in which the record is to be read. The facts that the animal is travelling in one direction, that the record reads in the opposite direction, and that there is no indication of this, renders the figure puzzling to any one unused to the interpretation of graphic records.

In fig. 22 the description in the text does not correspond with that under the cut. In the former the *convex* surface of the card strip is to be blackened, in the latter the *inner* surface is said to be blackened.

Most of the figures, however, are well executed and judiciously selected, and are so numerous that even unscientific readers will find no difficulty in following the descriptions of the apparatus by means of which such excellent results have been obtained.

Of especial interest are the pages devoted to a description of the application of the method

to the study of microscopic forms of life, though in this department but little progress has as yet been made. In England several amateur photographers are turning their attention to this work, and we have hopes of soon seeing considerable advances made.

Altogether the book is an excellent summary of the subject, and the appearance of an English translation will, we hope, stimulate to fresh endeavours the numerous amateur photographers who at present seem to find a difficulty in selecting some subject to which to turn their attention. In the past, the most remarkable advances in photography have been due to amateurs; in the future, we may expect equally brilliant results if only their efforts be properly directed. The subject treated in the book before us holds out great promises of success to any one taking up its study.

*A Monograph of the Mycetozoa*, being a descriptive catalogue of the species in the herbarium of the British Museum, illustrated with 78 plates and 51 woodcuts. By Arthur Lister, F.L.S. Printed by order of the Trustees, 1894.

Mr. Lister is well known as an authority upon the Myxomycetes, and his fine monograph, which appears under the auspices of the Trustees of the British Museum, will not only add lustre to the name of its author, but will prove a quite indispensable addition to the library of every one who is interested in this remarkable group of plants.

The introduction provides a useful general account of the organisms, whilst the diagnoses both of the main sub-divisions and also of the individual species are carefully and accurately executed, and to a great extent are based upon Rostafinski's work. Those species which, for various reasons, present special difficulties, are exhaustively dealt with, and the directions and limits of their individual variability are well defined.

We notice that here and there Mr. Lister has removed some forms from their old positions, and has located them in other genera. This is especially the case where the distinctive marks are perhaps not very obvious, and have thus been insufficiently appreciated by other writers less intimately familiar with the plants in question. Thus *Chondrioderma difforme* here reappears under the generic name of *Didymum*, with which it is certainly more appropriately classed.

Any notice of the book would be inadequate which omitted to mention the beautiful photographic illustrations which fill the 77 plates included in the volume. They are reproductions largely from Miss Lister's drawings, and of their wonderful fidelity, as well as of their beauty, it is impossible to speak in terms of too high praise.

*The Cell: Outlines of General Anatomy and Physiology*. By Dr. Oscar Hertwig. Translated by M. Campbell, and edited by Henry Johnstone Campbell, M.D. Swan Sonnenschein & Co., 1894.

The appearance of O. Hertwig's book, *Die Zelle und die Gewebe*, in 1893, marked an epoch in the progress of cytology. But so fast have new facts been accumulated that some of the statements and generalisations contained in the original work are to-day only of historical interest. It was then the more essential that a translator who proposed to edit such a book should himself be perfectly *au courant* with his subject.

But, as a matter of fact, we find many slips and inaccuracies in the volume which Dr. Campbell has given us, and some of these are not such as we should have expected to find in an "edited" translation. Thus, since the time at which Hertwig wrote, the generalisation as to the fusion of the centrosomes in conjugating cells has received several shocks before the present year, in which it seems to have received its final death-blow.

Again it seems odd that Dr. Campbell did not correct the errors which appear in the explanations of Figure 163, and which are equally made in the original. Furthermore, green swarm spores of algae are not usually termed Tetraspores.

But in spite of these and similar weaknesses in the book regarded as an edition, it will doubtless meet with a warm welcome as presenting to English readers the best general account of the cell which has yet been written, and one, moreover, from the pen of an investigator in the very front rank of cytological research.

*Protobasidiomyceten untersuchungen aus Brasilien*. Von Alfred Möller, mit 6 Tafeln. Jena: Gustav Fischer, 1895.

Dr. Möller is to be congratulated on having produced not only a most important work on the group of fungi with which he here specially deals, but one which will be read from cover to cover with ever-growing interest. The Protobasidiomycetes are here welded into a coherent

whole, a feat only rendered possible by the extensive series of investigations carried out by the author within the Tropics, to which the majority of the plants appear to be confined.

Dr. Möller treats first of the Auricularia group, which is characterised by the transversely septate basidia, and he points out their relationship to the Uredineæ through such forms as *Saccoblastia*. He traces the evolution of the thallus from a mere encrusting form with scattered basidia, such as occurs in the genus *Stypinella*, on to the more complete types exemplified in *Auricularia* itself. Further, he finds in *Pilacrella* a prototype of the angiocarpic *Pilacre*, a plant which has been rendered familiar to us by the classical treatise of Brefeld. And similarly in the Tremellaceæ, in which the basidia are divided vertically crosswise, he finds a corresponding gradation of form from a simple type such as *Stypella* to the most complicated species of *Tremella*. Furthermore, *Pilacrella* finds its analogue in *Hyaloria*, which is practically a *Pilacre* with Tremelloid basidia.

The two groups, Auriculariaceæ and Tremellaceæ, are linked together by *Sirobasidium*, in which, besides other peculiarities, the basidia are usually divided obliquely by a septum. But both the position and number of the septa may vary.

Perhaps the most interesting generalisation in the book is that which emphasises the fact that amongst the Protobasidiomycetes there occur all the type forms which are met with in the Autobasidiomycetes, with the exception of that of the Agarics. It remains to be seen how far this is the result of independent convergence. Dr. Möller strenuously opposes the assumption of any direct phylogenetic relationship existing between the Proto- and Autobasidiomycetes, and he follows, or perhaps even exceeds, Brefeld, in regarding the two divisions as constituting two fundamentally distinct series. At the same time, it must be borne in mind that even amongst the Tremellas themselves there exists some latitude in the degree of completeness with which the septation of the basidia is carried out, and we are ourselves inclined to attach a good deal less weight to this character than Möller appears to do. To attempt to draw a hard and fast line of demarcation between the two groups of fungi on the strength of a single character, such as the absence or presence of septa, appears to us to be a dangerous proceeding, and one which savours rather too much of an *a priori* method. And this reflection obtrudes itself the more strongly when we take some of the author's own instances into consideration; for example, it is solely on this character that *Proto-merulius* is severed from *Merulius* (with which in every other respect it closely corresponds), and is regarded as belonging to a different original stock,—the resemblance, though striking, being merely one due to convergence.

The author elaborates Brefeld's view that the basidium is nothing save a specialised conidiophore which bears a definite number of spores. If, however, the recent conclusions drawn from the study of the nuclei within the basidia turn out to be sound, this comparison may require revision.

A further series of observations on the formation of the conidia in the Protobasidiomycetes is of special interest. Dr. Möller finds that many of these plants (*e.g.*, *Pilacrella*) possess two distinct forms of conidia occurring on the same mycelium. One of these, the large form, germinates readily; the other, the small kind, with difficulty or not at all. This discovery is of importance, since both amongst the Ascomycetes and the Uredineæ a similar dimorphism is common; the small conidia have been in these groups mistaken for sexual cells, but it is now generally admitted that this opinion was erroneous.

It is quite impossible, within the limits of a short review, to do justice to Dr. Möller's book and to the plates and figures which accompany the text. It is emphatically a work which every one who is at all interested in Fungi should read for himself.

*The Structure of Man: An Index to his Past History.* By Dr. R. Weidersheim, Professor in the University of Freiburg. Translated by H. and M. Bernard. The translation edited and annotated and a Preface written by G. B. Howes, F.I.S., Professor of Zoology, Royal College of Science, London. London: Macmillan & Co., 1895.

In placing the above work before the English-reading public the translators have fulfilled a useful task, for although, in spite of the short time it has been published, Professor Weidersheim's *Der Bau der Menschen* is already widely and favourably known amongst scientific workers, yet a large class to whom the present translation will be of great use are debarred from referring to the original by the fact of its being in the German language.

The class which above all others will benefit by the publication of an English translation embraces the younger human anatomists, to whom only too often the learning of the dry details of the structure of man proves uninteresting in the extreme, chiefly because as at present taught such details appear merely as a long array of facts without obvious connection, and

apparently without bearing on function. The medical student of to-day, though he spends far more time on so-called scientific study than his predecessors, yet is as a rule profoundly ignorant of two subjects which would tend to give a living interest to his anatomical studies, *viz.*, Embryology and Comparative Anatomy. Moreover, at the time he is learning his Anatomy he as a rule possesses only a superficial knowledge of Physiology. What possible interest then can he take in the study of Anatomy?

The writer of the present notice remembers with gratitude the help which the "Collective Investigation Committee of the Anatomical Society of Great Britain and Ireland" afforded him during his dissecting-room days. Under the stimulus which the search for "abnormalities" gave, all text-book statements were minutely investigated, and the discussion occasioned by the discovery of an unusual point of structure made an indelible impression on the memory, not only of the special abnormality present, but also of the more usual normal arrangement. With a work such as that of Professor Weidersheim to set forth such abnormalities and to describe and explain their significance, the impression made would have been even more profound.

Not only the human anatomist, however, but also the beginner in the study of comparative anatomy will find the book useful, for, in the words of the preface, "such works awaken the mind to the comparative method of inquiry, and to the higher educational and philosophic issues to which it leads".

Any detailed criticism of the subject-matter of the book would be out of place here, seeing that the original is already well known. It may, however, be well to state that amongst the contents sections are devoted to the Integument and the Tegumental Organs, the Skeleton, the Muscular System, Nervous System, Sense Organs, Alimentary Canal, and the Respiratory, Circulatory and Urinogenital Systems.

The translation throughout is especially well done, and, as is desirable in treating such a subject, the text is profusely illustrated by excellent figures.

By no means least amongst the advantages of the present edition must be ranked the suggestive preface and valuable notes contributed by Professor Howes.

The work should be widely known, as it serves to correlate the theories of modern science with the facts of every-day experience.

## APPENDIX II.

### CHEMICAL LITERATURE FOR NOVEMBER, 1895.

Vol. I. No. 300. *American Journal of Science*. (December, 1895.)

*Penfield, S. L.*, Devices for the Separation of Minerals of high specific gravity (pp. 446-449).  
*Foot, W. M.*, Preliminary Note on a New Alkali Mineral (pp. 480-481).

Vol. xvii. No. 9. *American Chemical Journal*. (November, 1895.)

*Jackson, C. L.*, and *Grindley, H. S.*, Action of Soda Alcoholates on Chloranil. Acetals derived from Substituted Quinones (pp. 633-658). *Orndorff, W. R.*, and *Cameron, F. K.* Paranthracene or Dianthracene: A Polymeric Modification of Anthracene (pp. 658-681). *Campbell, E. D.*, On the Oxidation of some Gases with Palladinised Copper Oxide (pp. 681-692). *Kremers, E.*, Notes on Limonene and its Derivatives (pp. 692-697). *Wheeler, H. L.*, On the Action of Bromine on Metanitraniline (pp. 697-704). *Kastle, J. H.*, A New Reagent for Bromine and Iodine. Preliminary Notice concerning the Halogen Derivatives of Sulphonamides (pp. 704-708).

Vol. xx. No. 237. *The Analyst*. (December, 1895.)

*Bodmer, R.*, Note on a recent Milk Case involving a Sample of Abnormal Milk (pp. 265-268). *Bodmer, R.*, Note on Two Samples of "Filled" or Lard Cheese (p. 268). *Pearmain, T. H.*, and *Moor, C. G.*, The Composition and Analysis of Condensed Milk (pp. 268-274). *Allen, A. H.*, Note on Commercial Condensed Milks (pp. 274-276). *Williams, R.*, Note on the Iodine and Bromine Absorptions of Linseed Oil (pp. 276-277).

Vol. xiv. No. 11. *Journal of the Society of Chemical Industry*. (30th Nov., 1895.)

*Dibden, W. J.*, The Filtration of Sewage Effluent (pp. 915-922). *Shack Sommer, G.*, Chemical Industries as Auxiliaries for the Practical Farmer (pp. 922-929). *Davis, G. E.*, A Quarter of a Century in the Heavy Chemical Trade (pp. 929-935). *Carulla, F. J. R.*, Chairman's Address (pp. 935-939). *Mackay, W. McD.*, Spontaneous Combustion of Oils spread on Cotton (pp. 940-941). *Clark, J.*, Chairman's Address (pp. 941-944). *Mond, L.*, The History of my Process of Nickel Extraction (pp. 945-946). *Alberg, M.*, A Case of so-called "Spontaneous Combustion" (p. 947). *Eneyvist, J.*, The Utilisation of Waste Acid from the Parting of Gold and Silver (pp. 947-950).

Vol. xl. No. 247. *Philosophical Magazine and Journal of Science*. (Dec., 1895.)

*Sutherland, W.*, Molecular Force and the Surface Tension of Solutions (pp. 477-494). *Thomson, J. J.*, The Relation between the Atom and the Charge of Electricity carried by it (pp. 511-544).

Series vii. Tome vi. *Annales de Chimie et de Physique*. (December, 1895.)

*Lemoine, G.*, Études quantitatives sur l'action chimique de la lumière pour la décomposition mutuelle de l'acide oxalique et du chlorure ferrique (pp. 433-540). *Brillouin, M.*, Tensions superficielles et formes cristallines. Domaine d'action moléculaire (pp. 549-575).

Tomes xiii.-xiv. No. 22. *Bulletin de la Société Chimique de Paris*.

(20th November, 1895.)

*Thomas, M. V.*, Action de l'oxyde nitrique sur quelques chlorures métalliques : chlorures de bismuth et d'aluminium (pp. 1009-1010). *Lecoeuvre, E.*, Nouveau procédé volumétrique de dosage du nickel (pp. 1011-1013).

Tomes xiii.-xiv. No. 23. (5th December, 1895.)

*Delpine*, Préparation du nitrate de méthyle (pp. 1044-1045). *Mitignon, C.*, et *Deligny*, Sur les substitution nitrées (pp. 1045-1048). *Urbain, G.*, Sur les produits de condensation de l'aldehyde isobutyrique (pp. 1048-1052). *Freundler, P.*, Dédoublement de l'acide dioxystéarique (pp. 1052-1055). *Freundler, P.*, Sur quelques éthers tartriques chlorés (pp. 1055-1063).

Tome cxxi. No. 20. *Comptes Rendus hebdomadaires de l'Académie des Sciences*.

(11th November, 1895.)

*Nivière, G.*, et *Hubert, A.*, Contribution à l'étude des ferment (p. 670). *Vigouroux*, Sur les

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siliciures de nickel et de cobalt (pp. 686-689). *Dufau, E.*, Sur le chromite neutre de chaux cristallisé (pp. 689-691). *Lescœur, H.*, Sur les alcoolates (pp. 691-693). *Bourquelot, E.*, et *Hérissey, H.*, Sur les propriétés de l'émulsine des Champignons (pp. 693-696). *Winter, J.*, Constance du point de congélation de quelques liquides de l'organisme. Application à l'analyse du lait (pp. 696-698).

Tome cxxi. No. 21. (18th November, 1895.)

*De Boisbaudran, L.*, Sur un élément probablement nouveau existant dans les turbines (pp. 709-710). *Phipson, T. L.*, Sur l'origine de l'oxygène atmosphérique (pp. 719-721). *Aloureu, C.*, Synthèse du méthyleugénol. Constitution de l'eugénol (pp. 721-723). *Gérard, E.*, Sur les cholestérides des Cryptogames (pp. 723-726). *Bertrand, G.*, et *Malléore, A.*, Sur la diffusion de la pectase dans le règne végétal et sur la préparation de cette diastase (pp. 726-729).

Tome cxxi. No. 22. (25th November, 1895.)

*Grimaux, C.*, Sur la para-éthoxyquinoléine (pp. 749-752). *Pichard, P.*, Dosage rapide de l'azote nitrique dans les produits végétaux (pp. 753-760). *Gouy*, Sur les propriétés électro-capillaires de l'acide sulfurique étendu (pp. 765-768). *François, M.*, Action du phénol sur l'iodeur mercuréous (pp. 768-771). *Vigouroux*, Sur la silicure de manganèse (pp. 771-773). *Broginer, L.*, Sur la toxicité de l'acétylène (pp. 773-774). *Magnier de la Source, L.*, Sur quelques réactions de l'acide tartrique et des tartrates alcalins (pp. 774-776).

Tome cxxi. No. 23. (2nd December, 1895.)

*Moissan, H.*, Sur la présence du sodium dans l'aluminium préparé par électrolyse (pp. 794-798). *Troost, L.*, et *Ouvrard, L.*, Sur l'origine de l'argon et de l'hélium dans les gaz dégagés par certaines eaux sulfureuses (pp. 798-800). *Bouchard*, Observations relatives à la Communication de MM. Troost et Ouvrard (p. 800). *Moureau, C.*, Sur la présence de l'argon et de l'hélium dans une source d'azote naturelle (pp. 819-820). *Camprodron, L.*, Détermination expérimentale du pouvoir agglutinant des Louilles (pp. 820-822). *Féree, J.*, Sur l'amalgame de chrome et quelques propriétés du chrome métalliques (pp. 822-825). *Colson, A.*, Sur un mode de synthèse d'amides complexes (pp. 825-827). *Guye, P. A.*, et *Goudet, C.*, Nouveaux exemples de superposition des effets optiques de carbones asymétriques (pp. 827-829).

15<sup>e</sup> Année. Tome ii. No. 10. *Journal de Pharmacie et de Chimie.*

(15th November, 1895.)

*Berlioz et Lépinoy*, Examen d'un calcul amygdalien (pp. 433-435). *Bourquelot, E.*, et *Hérissey, H.*, Sur les propriétés de l'émulsine des champignons (pp. 435-440). *Chassevant, A.*, Action du benzène sur les microorganismes (pp. 440-442). *Grimbert, L.*, et *Choquet, J.*, Sur la présence du colibacille dans la bouche de l'homme sain (pp. 422-445).

15<sup>e</sup> Année. Tome ii. No. 11. (1st December, 1895.)

*Charrin, A.*, Les Antitoxines (pp. 481-488). *Py*, Notes sur l'analyse des sucs de fruits, sirops et confitures (pp. 488-491).

Tome xxvii. No. 7. *Journal de la Société Physico-chimique Russe.*

*Ipatieff, W.*, Action de l'acide bromhydrique sur les hydrocarbures  $C_n H_{2n-2}$  (pp. 388-409). *Konowaloff, M.*, Action nitrifiante de l'acide nitrique sur les dérivés des hydrocarbures aliphatiques (pp. 409-412). *Konowaloff, M.*, Données concernnant le pouvoir refrigeant des combinaisons azotées (pp. 412-421). *Konowaloff, M.*, Action nitrifiante de l'acide nitrique sur les hydrocarbures aliphatiques (pp. 421-428). *Poehl, A.*, Sur un substance colorante de l'urine (pp. 428-431). *Schkatelloff, W.*, Sur l'identité de l'acide abiétique et de l'acide silvique (pp. 431-433). *Lidoff, A.*, Sur la composition de la mine d'asphalte de Kertsch (pp. 433-436). *Kütheroff, M.*, Dosage de l'huile de fusel dans les alcools. *Kijner, N.*, Sur les métamorphoses des méthylamines droit et gauche. *Zelinsky, N.*, Sur le diméthylpentaméthylène. *Scouperovský, B.*, Sur le dosage des matières organiques dans l'eau au moyen du permanganate de potasse. *Tikhinsky, M.*, Sur les formes tautomériques des homologues de phénol-rosinduline. *Charitschkooff, C.*, Sur les méthodes de l'analyse de la naphté (pp. 436-452).

Band cclxxxix. Heft 1. *Justus Liebig's Annalen der Chemie.*

(22nd November, 1895.)

*Bredt, J.*, und *Rosenberg, M. V.*, Partielle Synthese des Kamphers und ueber die Constitution der Kamphersäure und des Kampherphorons (pp. 1-15). *Bredt, J.*, Ueber die von

Herr Ziemann angenommenen Constitutions formeln für Kampher und Kampholinsäure (pp. 15-20). *Schulz, M.*, und *Tollens, B.*, Ueber die Verbindungen der mehrwerthigen Alkohole mit Formaldehyd (pp. 20-34). *Apel, M.*, und *Tollens, B.*, Ueber das Pentaerythrit-di-benzal (pp. 34-36). *Apel, M.*, und *Tollens, B.*, Ueber das Pentaglycol, einen aus Formaldehyd und Isobutyraldehyd synthetische hergestellten Zweierthigen Alkohol (pp. 36-46). *Apel, M.*, und *Tollens, B.*, Ueber das Anhydro-ennea-heptit aus Formaldehyd und Aceton (pp. 46-52). *Petrenko-Kritschchenko, P.*, *Pissarschewsky, L.*, und *Herschkowitsch, M.*, Ueber die Wirkung der Substitution auf den Gang der Ketonreactionen I. (pp. 52-58). *Petrenko-Kritschchenko, P.*, und *Ephrussi, S.*, Ueber die Wirkung der Substitution auf den Gang der Ketonreactionen II. (pp. 58-61). *Hesse, O.*, Ueber Triesorcin (pp. 61-71). *Beckmann, E.*, und *Schlieb, G.*, Zur Kenntniss der organischen Metallverbindungen (pp. 71-90). *Möhla, R.*, und *Uhlmann, K.*, Zur Kenntniss der Chinazin und Oxazinfarbstoffe (pp. 90-130).

Jahrgang xxviii. No. 17. Berichte der Deutschen Chemischen Gesellschaft.

(25th November, 1895.)

*Walden, P.*, Weiteres ueber optisch active Halogenverbindungen (pp. 2766-2773). *Meyer, V.*, Zur Esterbildung aromatischer Säuren (pp. 2773-2776). *Heyl, G.*, und *Meyer, V.*, Ueber eine neue Behandlung des Benzol Problems (pp. 2776-2798). *Kerschbaum, M.*, Ueber Synthesen mittels Chlorjod (pp. 2798-2804). *Meyer, V.*, und *Raum, W.*, Ueber die andauernde Einwirkung schwacher Erhitzung auf Knallgas (pp. 2804-2807). *Staats, G.*, Ueber den gelben Blattfarbstoff der Herbstfärbung (pp. 2807-2809). *Niemontowski, S.*, und *Orzechowski, B.*, Synthesen der Chinolinderivate aus Anthranilsäure und Aldehyden (pp. 2809-2822). *Jannasch, P.*, Ueber die Aufschliessung der Silicate durch Borsäure (pp. 2822-2823). *Jannasch, P.*, Bemerkung (pp. 2823-2824). *Bischoff, C. A.*, Studien ueber Verkettungen II. Conjugirte Malonsäureester (pp. 2824-2835). *Hell, C.*, Ueber Darstellung von Ketonen aus aromatischen Propenyl ( $\text{CH}:\text{CH}_2\text{CH}_3$ ) verbindungen (pp. 2835-2838). *Reformatsky, S.*, und *Plesconosoff, B.*, Die Einwirkung eines Gemenges von Zink und Bromisobuttersäureester auf Aceton. Synthese der Tetramethyläthyleinmilchsäure (pp. 2838-2842). *Reformatsky, S.*, Die Einwirkung eines Gemenges von Zink und Bromisobuttersäureester auf Isobutyraldehyd. Synthese der secundären  $\beta$ -Oxysäuren (pp. 2842-2847). *Brühl, J. W.*, Ueber das Wasserstoffhyperoxyd (pp. 2847-2866). *Brühl, J. W.*, Ueber die Constitution des Wassers und die Ursache seiner Dissociationskraft (pp. 2866-2868). *Brühl, J.*, Nochmals ueber Esterificirung und Verseifung (pp. 2868-2869). *Gattermann, L.*, Ueber gefärbte aromatische Thioketone (pp. 2869-2878). *Auwers, K.*, Ueber Beziehungen zwischen dem kryoskopischen Verhalten der Phenole und ihrer Constitution (pp. 2878-2882). *Emmerling, O.*, Ueber Thiorufinsäure und Thiocaracetessigester (pp. 2882-2888). *Auwers, K.*, Ueber ein abnormes Tribromderivat des Pseudocumenols I. (pp. 2888-2902). *Auwers, K.*, und *Marwedel, J.*, Ueber ein abnormes Tribromderivat des Pseudocumenols II. (pp. 2902-2910). *Auwers, K.*, und *Avery, S.*, Ueber ein abnormes Tribromderivat des Pseudocumenols III. (pp. 2910-2924). *Traube, J.*, Molekularvolumetrische Methode der Molekulargewichts- und Constitutionsbestimmung II. (pp. 2924-2929). *Gabriel, S.*, und *Stetsner, R.*, Ueber Vinylamin (pp. 2929-2938).

Jahrgang xxviii. No. 18. (9th December, 1895.)

*Zelinsky, N.*, und *Tschugaeff, L.*, Ueber Trimethyldioxyglutarsäure (pp. 2940-2943). *Zelinsky, N.*, und *Reformatsky, A.*, Ueber Trimethylpimelinsäure und einige ihrer Umwandlungsproducte (pp. 2943-2946). *Zelinsky, N.*, und *Porchanow, A.*, Ueber die Einwirkung von Tetrachlorkohlenstoff auf Natriummalonäure methylester (pp. 2946-2947). *Hinsberg, O.*, und *König, F.*, Zur Darstellung von Orthophenylenediamin (pp. 2947-2948). *Zincke, Th.*, Ueber die Einwirkung von Unterchloriger Säure auf Diazoverbindungen (pp. 2948-2952). *Goldschmidt, C.*, Ueber eine Synthese des 3:5 Methylphenylpyrazol (p. 2952). *Euler, W.*, Synthese der  $\beta$ -Methylpentamethendi-und-monocarbonsäure (pp. 2952-2959). *Meyer, R.*, und *Meyer, H.*, Studien in der Phialeingruppe (pp. 2959-2963). *Meyer, R.*, und *Meyer, H.*, Ueber directe Bestimmung von Benzoyl- und Acetyl-gruppen (pp. 2965-2969). *Nietzky, R.*, Ueber amidoderivate des Diphenylamins und ihre Beziehungen zu den Indaminen und Azinen (pp. 2969-2981). *Brühl, J. W.*, Ueber das Benzolproblem (pp. 2981-2986). *Lustig, F.*, Ueber einige Amidoderivate des p-Xylols (pp. 2986-2994). *Knoevenagel, E.*, und *Renner, W.*, Einwirkung von Hydroxylamin auf Benzalacetessigester (pp. 2994-3000). *Winther, C.*, Zur Theorie der Spaltungen der racemischen formen

(pp. 3000-3024). *Fischer, E.*, Ueber die Isomaltose (pp. 3024-3028). *Fritz, V.*, Ueber einige Derivate des Benzoylcarbinols und des Diphenacyls (pp. 3028-3034). *Fischer, E.*, und *Lindner, P.*, Ueber die Enzyme einiger Hefen (pp. 3034-3039). *Pinnow, J.*, Ueber Derivate des Dimethyl-p-toluidins (pp. 3039-3045). *Jünger, E.*, und *Klages, A.*, Zur Kenntniss der Lethofellinsäure (pp. 3045-3049). *Reverdin, F.*, und *Kaufmann, H.*, Ueber einige Substitutionsproducts der Carbonate und Phosphate von  $\alpha$ - und  $\beta$ -Naphtol, sowie Darstellung von Chlornaphtol- $\alpha$ '-4 und Bromnaphtol- $\alpha$ '-4 (pp. 3049-3059). *Vaubel, W.*, Berichtigung (p. 3059).

Band lii. Nos. 19, 20, 21. *Journal für praktische Chemie*. (2nd Nov., 1895.)

*Michael, A.*, Untersuchungen ueber Alloisomerie III. (pp. 289-326). *Michael, A.*, und *Clark, T. H.*, Relative Leichtigkeit der Kohlendioxydabspaltung aus den Silbersalzen der  $\beta$ -Chlorcrotonäsuren (pp. 326-331). *Michael, A.*, und *Tissot, G.*, Ergänzungen früherer Arbeiten (pp. 331-344). *Michael, A.*, Ueber die Gesetze der Alloisomerie und Anwendung derselben zur Classificierung ungesättigter organischer Verbindungen (pp. 344-365). *Michael, A.*, Bemerkungen zu Arbeiten von C. A. Bischoff, J. A. Wislicenus, und J. H. Van t' Hoff (pp. 365-373). *Busch, M.*, Zur Kenntniss der  $\alpha$ -Amidobenzylamine II. (pp. 373-417). *Vaubel, W.*, Ueber das Verhalten einiger Benzolderivate gegen nascirendes Brom. IV. (pp. 417-424). *Kijner, N.*, Ueber die Wirkung von Silberoxyd auf Brommenthylamin. Die Bildung von Menthylhydrazin.  $C_{10}H_{19}NH_2$ . (pp. 424-426). *Kijner, N.*, Ueber die Wirkung von Hydroxylamin auf das 1-Dibrommenthylamin (pp. 426-428). *Haeussermann, C.*, und *Teichmann, H.*, Zur Kenntniss der Diamidobenzoësäuren II. (pp. 428-429). *Walther, R.*, Ueber die Einwirkung von Orthoameisäther auf primäre aromatische Amine (pp. 429-431). *Deinert, J.*, Notiz ueber die Umwandlung der Nitrile in Amide durch Wasserstoffsuperoxyd (pp. 431-432).

Band xvi. Heft 9. *Monatshefte für Chemie und Verwandte Theile Andere Wissenschaften*. (6th November, 1895.)

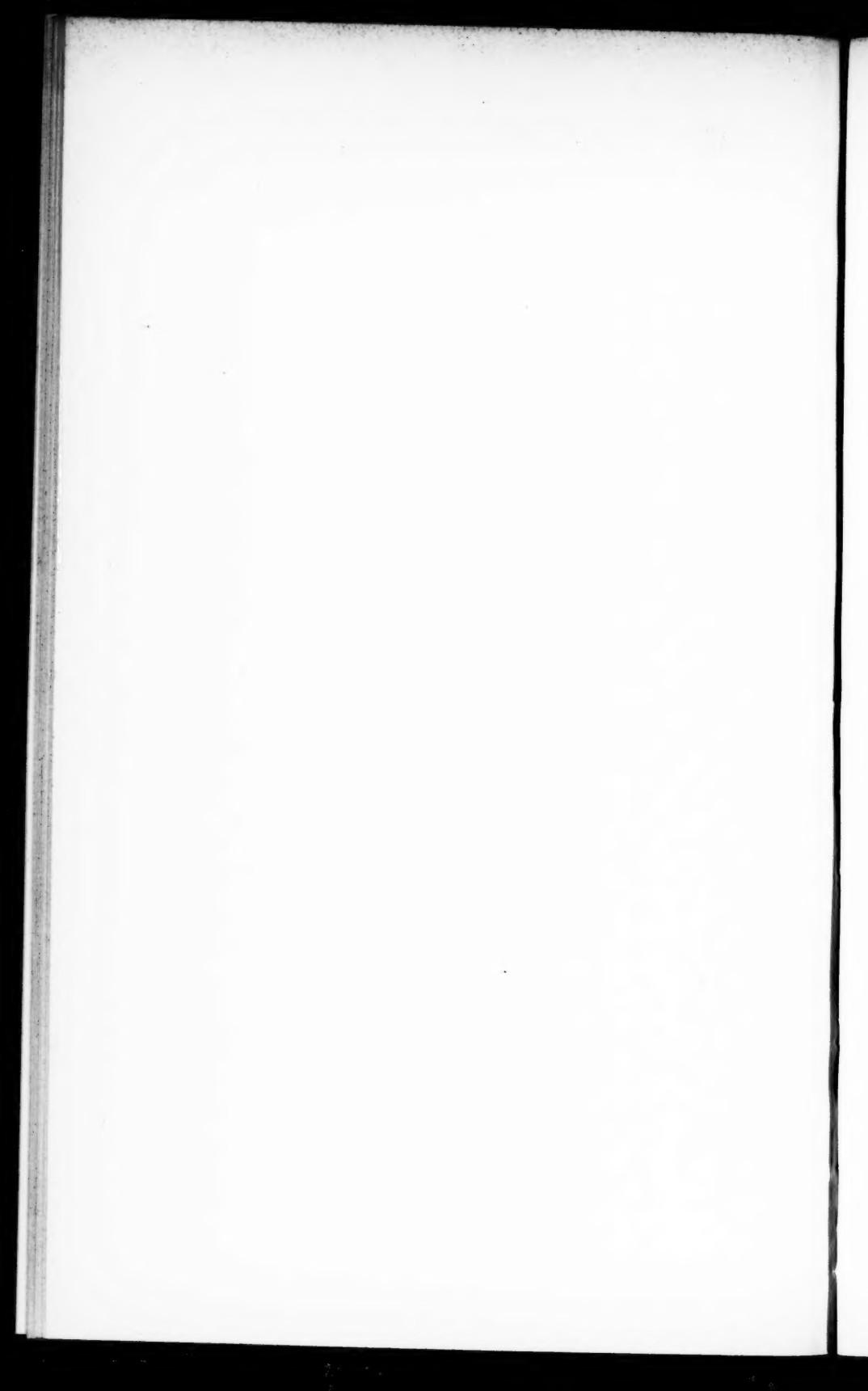
*Goldschmidt, G.*, und *Schranshofer, F.*, Ueber die Hydrazon des fluorenons und seiner Substitutionsprodukte. I. (pp. 807-828). *Hirsch, R.*, Ueber Papaveraldoxin (pp. 828-849). *Brunner, K.*, Ueber eine neue aus dem Isobutylidenhydrazen gewonnene Base (pp. 849-866). *Baczewski, M.*, Chemische Untersuchung der samen von Nephelium lappaceum und des darin enthaltenen Fettes (pp. 866-881). *Gregor, G.*, Ueber die Einwirkung von Jodäthyl auf  $\beta$ -resorcylsaures Kalium (pp. 881-893). *Eder, J. M.*, und *Valenta, E.*, Ueber das rothe Spectrum des Argons (pp. 893-815).

Band xviii. Heft 3. *Zeitschrift für Physikalische Chemie*. (29th November, 1895.)

*Wald, F.*, Die Genesis der stöchiometrischen Grundgesetze (pp. 337-376). *Ley, H.*, Ueber die Geschwindigkeit intramolekularer Reaktionen bei raumisomeren Oximen (pp. 376-399) *Jahn, H.*, Ueber die von der Batterie während der Zersetzung gelöster Elektrolyte zu leistende Arbeit, sowie ueber die an den Elektroden polarisierter Zersetzungszellen lokalisierten Wärmetonungen (pp. 399-426). *Tammann, G.*, Zur Wirkung ungeformter Fermente (pp. 426-443). *De Lannoy, S.*, Experimentelle Untersuchungen ueber die thermische Ausdehnung von Salzlösungen. I. (pp. 443-473). *Beckmann, E.*, *Fuchs, G.*, und *V. Gernhardt*, Beiträge zur Bestimmung von Molekulargrößen. III. (pp. 473-514). *Brühl, J. W.*, Ueber die Konstitution des Wassers und die Wischen seiner Dissociationskraft (pp. 514-519). *Bakker, G.*, Ueber die innige Verdampfungswärme (pp. 519-521). *Wood, R. W.*, Notiz ueber den Dissociationsgrad einiger Elektrolyte bei Null Grad (pp. 521-524).

Anno xxv. Vol. 2. Fascicolo 4. *Gazzetta Chimica Italiana*. (1st Nov., 1895.)

*Zecchini, F.*, Sopra una nuova formula per esprimere la rifrazione specifica dei liquidi (pp. 269-285). *Rap, E.*, Sull' $\alpha$ -benzoleumarone (pp. 285-290). *Rizzo, N.*, Sui prodotti di decomposizione e sulle anidridi dell'etere santonoso (pp. 290-298). *Albanese, M.*, Sul contenuto della cafféina e della teobromina nell'organismo (pp. 298-322). *Ciamician, G.*, e *Silber, P.*, Sulla costituzione della maclurina e della floretina (pp. 322-330). *Ciamician, G.*, e *Silber, P.*, Sulla fenileumarina e sulla cosidetta dicotoina (pp. 330-348). *Castoro, N.*, Sui derivati benzilici degli acidi santonosi e delle desmotroposantonine (pp. 348-359). *Lamberti-Zanardi*, Sopra alcuni nuovi prodotti di sostituzione alogenica del carbazol (pp. 359-364).



## APPENDIX I.

### NOTICES OF BOOKS.

*Lectures on Human and Animal Psychology.* By Wilhelm Wundt (translated from second German edition by J. E. Creighton and E. B. Titchener). London : Swan Sonnenschein, 1894.

The particular interest of this book is, that appearing so long ago as 1862, it is still in touch with the problems that are interesting us to-day as physiological psychologists. It is true that Professor Wundt rewrote it in great part in 1892, but the general trend of the work is the same as in the original, and it is very remarkable to see how what in 1862 was avowedly a programme is now in 1895 a working class-book of experimental psychology. Wundt himself says (preface to second edition) that "the physiological correlates of psychical processes" are less developed here than in the *Physiologischen Psychologie*, and that he devotes few words to subjects elsewhere discussed in detail, and gives more attention to others less prominent, especially in the last-named work. On this account the *Human and Animal Psychology* must not be taken as superseding the *Physiological Psychology* for English readers—hardly even as an introduction to it (as seems intended in the translators' preface). We should ourselves in preference turn to the larger work for general presentation of any subject.

In view of the development of experimental psychology, it is interesting to note that Wundt has rewritten the chapters on Sensation, where laboratory work comes so much into evidence, while other more theoretical parts, e.g., his theory of sense-perception by spatial localisation, have only undergone revision. And the new section is that on Will, Attention, Apperception, Association, so familiar to us all, as names, under Wundt's superscription. A short summary of the contents of the book, pausing at one or two points of present interest, may best indicate to what extent Wundt is the representative of "the new psychological movement" (translators' preface).

In 1862 it really was necessary to vindicate the claims of Psychology to be regarded as one of the natural sciences, independent of metaphysics. Wundt had to teach that not metaphysical questions, but "the uniformities of relation in the phenomena presented to our observation," are its subject-matter, and he was probably the first to assert that experimental psychology makes possible for philosophy that "absolutely impartial consideration of experience" in which alone metaphysical problems can hope for solution. On the other hand, he expressly points out that it is not merely chemical and physical investigation of the brain, but experimental observation of *the mind itself*, which must be the starting-point of psychology. [It will be remembered that Wundt uttered a strong protest last year (*Ueb. psychische Causalität, etc., Phil. Stud.*, xi.) against the "experimental psychology which reduces psychological processes to anatomical elements, until it almost appears as an appendix to muscular contraction".] Yet the nature of psychological facts is such that only the mental phenomena which are directly accessible to physical influences can be made the subject-matter of experiment, i.e., the organs of sense and movement which are functionally related to mental processes. Hence it comes about that every psychological experiment is at the same time physiological, and *it is this new method of experiment which characterises the modern treatment of psychology*. The image of the external object or idea is the proper starting-point of a psychological analysis. Under Ideas, Wundt includes, (1) *sense-perceptions*, which depend upon direct excitation of the organs of sense; (2) *memories of such sense-perceptions*; (3) *images of fancy*. He protests against the separation of "ideas," as images of memory and fancy, from "perceptions," as direct effects of sense-impression. No essential psychological difference can be discovered between them, while sense-perceptions themselves might well be taken for illusions of sense. The first step in analysis must be to reduce the Idea to its simple constituent elements, or sensations. Sensations again have two properties, (a) *strength or intensity*, (b) *quality*. Neither of these can exist in the absence of the other, but they can be varied independently.

Starting with intensity we have first to find a measure of quantitative difference between sensations, and secondly the relation between stimulus and sensation. Wundt's account of Weber's Law, as formulating the latter, is clear and instructive, although based, in this work, on the least exact method of discrimination, i.e., that of *minimum perceptible*

*difference.* The interpretation of the law may detain us for a moment, as the question it raises is still under discussion. Three interpretations are possible: (1) physiological, (2) psychological, (3) psycho-physical. Wundt himself subscribes to the second, *i.e.*, holds that the disproportion between increment of stimulus and increment of sensation takes place on *psychological* ground, between the sensificatory brain-charge, or internal stimulus, and the sensation. Delboeuf and others maintain that it is *physiological*, *i.e.*, that the internal stimulus is already a logarithmic function of the external objective stimulus, and that sensation increases in direct proportion with it. Confirmation of this from the physiological side appears in the recent observations of A. D. Waller (*Brain*, 1895, "Points relating to the Weber-Fechner Law, Retina; Muscle; Nerve") on muscle and retina, where, assuming the electrical signs of physico-chemical action recorded by galvanometer photographs to represent the sensificatory changes consequent on excitation of living matter, he finds that the internal change is always a logarithmic function of the external stimulus; the curves agree with the classical Weber-Fechner curve. (Wundt gives an excellent summary of the arguments on either side, up to 1893, in the fourth edition of his *Grundzüge d. physiol. Psychologie*, i., 390, where the position is much more clearly stated than in the work before us.)

In the absence of physiological evidence as to the relation of external to internal stimulus, Wundt had interpreted the Weber-Fechner Law by the psychological *Principle of Relativity*, finding "in the law of the logarithmic relation of sensation to stimulus a mathematical expression for a psychological process of universal validity". And under this principle he marshals all the remaining phenomena of sensation quantitatively apprehended, whether as regards intensity, or degree of quality. In our sense experience, we never deal with an isolated magnitude—there is always a process of comparison between the sum of previous experience, *i.e.*, former sensations, and the individual sensation of the moment. This principle is applied to the analysis of the several senses—sight and hearing being more fully treated. The physical data in either case are lucidly presented, and will be valuable to the student who has not had access to the general literature of the subject. The section on Contrast Phenomena opens up the Helmholtz-Hering controversy, *viz.*, whether contrast colours are due to subjective error of judgment, or to direct physiological interference with one another. Wundt prefers to denote the process underlying contrast as one of "associative contrast"; "contrast" there must be, on the principle of relativity, but "judgment" in his estimation belongs to a different category (*cf.* recent discussion in *Pflüger's Archiv*, xxvii., xxxix., xl., xli., etc.).

How are Ideas built up from these sensational elements? Wundt next develops his theory of *sense-perception by spatial localisation*, analyses the mental processes of association in the several senses, and connects the separate elements of an association into a single idea.

Every sensation, when of sufficient intensity, and not inhibited by opposing influences, is followed by a muscular movement. Such movements we term reflex, and these reflexes gradually become purposive and definite (*e.g.*, light-stimuli at first excite merely irregular movements. After time these take on a definite form, and serve a definite purpose; the eye moves in such a way as to bring the image of the stimulating light upon the yellow spot,—and if the light moves to and fro within the field of vision, the eye follows it with a continuous movement). The reflex thus controlled, and made to serve a definite purpose by the sensations inseparable from the movement itself, *muscle-sensations* being here singled out as illustrative. This brings us to another of the disputed questions in current psychology. Are the muscle-sensations (sense of effort, muscular sense) peripheral only, confined to muscle, skin, etc., or is there also central motor innervation? Here Wundt expresses himself with no reservation: our sensations of movement are by no means dependent solely upon the external or internal work performed by the muscles, but are influenced also by the intensity of the impulse to movement proceeding from the central organ in which the motor nerves originate. (This controversy, and the evidence deduced from the study of fatigue, the after-effect, and presumably correspondent of, muscular action, are admirably summed up in the *Physiol. Psychologie*, i., 426-434.) Leaving the question of the origin of sensations of muscular effort, Wundt finds pathological support of his conclusion that our recognition of the position of an object is normally based upon the sensation of effort attending the movement of the sensory organ to the object. For when muscular movements have been disorganized by paralysis, or other disturbances, there is often more or less complete re-adaptation to the new physiological conditions. So that if the power of localisation may be gained afresh after a transformation of the whole system of muscle-sensations we may assume that, when sense-perception in general was in process of development, the establishment of a relation between muscle-sensations, and the place from which an external stimulus operates, was a matter of slow and gradual evolution.

At the early stage now under consideration "purposive" and "definite" of course mean no more than the *simultaneous* or *successive association* of the sensations excited by the operation of a sense-stimulus. In the eye (to take the simplest case of muscular mechanism) association connects together the whole number of sensations excited in and round the eye, and systematises those sensory processes which begin with the simple light-sensation; it determines the form in which the eye transforms its sensations into perception. *This form is space-perception.* Hence Wundt infers that the perception of space, psychologically regarded, is not an innate possession of the mind, but the product of an association of sensations. This again is a crucial point in Wundt's psychology, in which (together with Helmholtz, and to some extent Lotze) he differs from Hering, who maintains that space-perception is innate and intuitive, and also from the English "Associationists". Wundt regards it as a mental growth depending on elementary experiences, tactile and visual, e.g., in the latter on the action of the ocular muscles. We obtain an independent knowledge of space relations by the eye, not merely from inherited facts of past experience, although he admits of these that they form a certain psycho-physical "disposition" which abridges the process of individual space-construction.

And it is to the common action of the two organs of vision that we owe the greatest part of our ideational development. Binocular vision is of fundamental import. The fusion of the separate perceptions of the two eyes (*central fusion*, "the *mental resultant* of the originally separate perceptions") into a single idea is typical of the mental processes of association, as is the disorganisation which ensues when these perceptions cannot be co-ordinated.

Ideas are thus derived from sensations in the regular course of development. But the human mind never apprehends sensations with absolute indifference. In cognising we always "feel" attraction or repulsion, or again are incited to some kind of action. *Feeling* and *Will* are the accompaniment of ideas and sensations. No separation in the last resort is possible between sense and feeling.

We sense and we feel; sense-feeling is the affective tone of sensation, and is therefore among the elementary constituents of our mental life, while the higher intellectual and esthetic feelings fall under the complex processes of consciousness. Will is not choice (which is a complex process, and implies the pre-existence of simple volition), nor is it the outcome of reflex action. Even the animal protozoa, much more the chick and the child, give plain evidence of voluntary movement. Purposive reflexes have much rather been evolved by practice from volitional actions. A *motive* is a particular idea with an affective tone attaching to it, and *motives* are the causes of volition, internal and psychical. In volition, however, as in sensation, the chief motive is not some particular sense-impression, but the entire trend of consciousness, as determined by previous experiences, often indeed "sub-conscious," not realised. It is the conflict of motives that gives to some voluntary actions the feeling of choice; where the present impression is very strong, and over-rules the rest, we have the sense of decision.

The *Theory of Volition*, shortly stated, is as follows:—

Feeling is independent of volition, but the reverse is impossible; voluntary activity always presupposes an antecedent voluntary tendency or feeling. Both these are elements of one common process. "*Activity*" implies two factors: (1) *a change that occurs*; (2) *a subject postulated to explain the change*.

In voluntary activity *the change* is always an alteration in the state of consciousness; an idea arises or disappears, becomes clear or obscure, etc. These ideational processes are invariably connected with feelings and emotions. In external voluntary actions the changes which refer to movements of the body (muscle-sensations, etc.) play the most important part. The *active subject*, which is the direct cause of these ideational changes, may be called "self," "ego," and again "willing subject," and so on, but in reality it is the sum of past experiences, i.e., "consciousness". *Will* is therefore (a) *feeling*; (b) *change in ideational content*; (c) *dependence of this change upon the whole trend of consciousness*.

*Consciousness* is essentially a dynamic process. The mind is not a "stage," remaining when the "actors" have left—no idea once passed out of consciousness returns to it again. New processes arise which exhibit relations and similarity to previous processes, but are not identical with them. Nor is "consciousness" itself a mental fact, separable from its constituent processes; "in" and "out" of consciousness is a misnomer. It is *in having* the process that we are conscious of it,—the range of consciousness must be conceived as denoting simply *the sum of mental processes existing at a given moment*. But as a collective expression the concept is indispensable.

The range of consciousness at any moment can be worked out experimentally, e.g., for auditory impressions. It is defined as the clear and distinct ideas apprehended by *appception* together with the obscure ideas that are partly discriminated by *perception*. The *perceived* ideas lie in the field of consciousness; the *appceived* are situated at its fixation point and proceed *pari passu* with that of Self-Consciousness. The development of *Attention*, which is either active or passive. And as in the elementary mental processes, "feelings were found to be invariable forerunners and concomitants of volition," so here "ideas and the feelings that are connected with them serve as motives to the act of appception, while appception itself shows all the characteristics of an act of will. More than this, its two fundamental forms, the active and passive, obviously correspond to the two fundamental forms of conative activity, the passive form, the impulsive act, and the active, or act of choice.

"Now it is plain that these internal acts of will are not only the analogues of the external, but at the same time their condition. There can never be an external act save as the result of a previous inner selection, and this holds again both of the impulse and of the act of choice, so that *Appception is the one original act of Will.*"

It is difficult to summarise the criticism directed against Wundt's Will and Appception theories, because no two critics attack the same point, nor do they seem usually to know what it means, or what they mean by its meaning. Marty, e.g. ("Ueb. sprach Reflex," etc., *Viertel. jhr. schrift. f. Wiss. Phil.*, xiii., 1889), finds a confusion between Will and Affective Emotion, protesting that, while emotional were formerly classed under volitional reactions, Will is now proposed as subsidiary to the Emotions. Feeling is indifferently the stimulus of Will, and the reflex excited by it. The fact no doubt is, as Prof. Titchener elsewhere expresses it (*Mind*, i., n. s., 1892), that in Wundt's psychology, the words "will" and "appception" have a two-fold meaning: (1) as indicating a primitive mental activity, (2) as expressing the complex states derived from this in different directions.

The best discussion is that of Külpe in *Phil. Stud.*, v., 1889. He groups the rival theories broadly into two classes—negative and positive. The former, or "physiological" school, of which Münsterberg is the chief exponent, deny that Will is an elementary constituent of Consciousness, and reduce it to a derivative of sensation and feeling: the other, the "psychological" group, headed by Wundt, take the strictly empirical view that Will, like sensation and feeling, is a primitive element. Külpe adheres to the latter, and insists that, while some psychologists seem to shrink from reckoning spontaneous activity among the facts of consciousness, there must still remain, when we have separated out ideation, sensation and feeling, an independent qualitative factor which is best described as internal spontaneous activity.

It is, perhaps, legitimate to ask why this fundamental activity should be termed "Will," unless will is identical with function—as it is in the last resort. But the precise terms must always be ambiguous. The burning point that enforces itself upon us is Wundt's conception of Consciousness as a relation, a synthesis—a summated whole, and not a system of detached compartments, or worse, a "background," as it is still unfortunately described by some writers.

The same section treats of the rhythm or fluctuation of Attention, which has recently been the subject of so much physiological experiment and argument. Wundt, of course, refers it to a central periodicity of the appceptive process, to central oscillations of attention, while his opponents regard it as dependent on purely physiological conditions in the peripheral sense-organs and muscles (Münsterberg, G. E. Müller).

*Reaction-times* are discussed as the method for registration and measurement of mental processes; a more rapid reaction is obtained in the sensorial form (where the sense-organ is attended to) than in the muscular (where attention is directed to the organs of movement) (Titchener, cf. *Phil. Stud.*, viii.).

*Association-times* furnish another interesting section. Wundt finds that a single letter takes from ten to twenty seconds more to cognise in German than in Roman type, whereas the entire word can be read with great facility in the one as in the other. In the same way one finds on plunging into the life of a foreign town that familiar subjects are understood almost at once, while it takes an immense time to grasp the immediate sense of an unexpected topic.

*Simultaneous Association* is the simplest form, in which the associated ideas are not successive, but come into consciousness as a simultaneous ideational complex, connected by their mutual relations in consciousness without any direct implication of memory.

In *Assimilation* the memory image takes the lead, and presides over the incoming sensations, perhaps forming a wrong concept; indistinct sounds, e.g., may be represented by a wrong set of memory ideas. Hence the familiar beaker experiment, and other sense illusions, due to *delay* in assimilation of new sense impressions by the habitual memory

elements, and sense illusions proper where the ideas excited by association permanently outweigh the direct sense impressions. Next comes *Successive Association*, (1) immediate, (2) mediate, a section which Wundt is constantly elaborating; cf. *Phil. Stud.*, x., 2, where he refers the experience of an idea, or memory image, called up by the unnoticed scent of a flower, quoted by Jerusalemi as a case of an "unconscious" middle factor, to the category of an unrecognised, but *not unconscious*, factor—dimly perceived, but not apperceived in consciousness.

He next discusses the "intellectual, conscious processes," which include *concepts, judgments, and apperceptive connections of ideas*.

The complex affective processes are summarised as Emotions, and the expression of the Emotions—Instinctive and Voluntary Action—with a concluding chapter on Immortality, Phrenology, and the Principles of Psycho-physical Parallelism. It is impossible in the limits of a review to give a competent outline of the contents of this book, one falls between the catalogue and the encyclopædia. The physiological sections are the most convincing, and command respect for the profundity and grasp of Wundt's treatment in comparison with the superficial handling of some later writers.

A translation from the hands of Prof. Titchener carries its own recommendation. He is so strong on the point of "psychological nomenclature" that he doubtless has good reasons for introducing such unfamiliar terms as "clang," "clang character," "clang compound," "deception of judgment," "just noticeable difference," etc. But in lecture vi. it is difficult to subscribe to the rendering of "farbos" by "bright," "brightness" (throughout the chapter). Why not *a-chromatic*? The division into numbered sections is a distinct help towards acquaintance with the subject-matter.

F. A. WELBY.

*An Introduction to the Study of Seaweeds.* By George Murray, F.R.S.E., F.L.S. London: Macmillan & Co., 1895.

Mr. Murray's name is well known in connection with Algae from his researches published in *Phycological Memoirs* (of which he is editor), his *Catalogue of the Marine Algae of the West Indian Region*, and other works.

The book before us opens with an introduction of thirty-three pages, dealing shortly with the history of Phycology, with geographical distribution of seaweeds and the causes affecting it, and includes hints on collecting. This is followed by a short Bibliography; and the remainder of the volume is occupied with the general morphology of the seaweeds.

For reasons of convenience the Phaeophyceæ are described first, but it seems rather a pity that the sub-classes should be numbered in the order adopted, viz., Phaeophyceæ, Chlorophyceæ, Diatomaceæ, Rhodophyceæ, Cyanophyceæ.

The results of some of the researches recently published in the *Phycological Memoirs* are incorporated in the descriptions, and several of the genera described and figured are uncommon ones, and information about them difficult to get. These features, and also the large number of excellent illustrations, contribute largely to the value of the book. There are eighty-eight figures, representing habit, microscopical structure, etc., besides eight coloured plates. With these numerous illustrations it is hardly fair to ask for more, but one would have liked *one* figure of the conjugation of planogamete, to compare with the fertilisation of *Fucus*.

The Bangiaceæ are, no doubt rightly, excluded from the Rhodophyceæ (p. 248), but a comparison of *Porphyra* with *Prasiola* might, perhaps, have been added by way of a suggested relationship.

The descriptions are mostly concise, but a few statements are made in rather too general terms to be of much service; thus (on p. 113, last line), some of the Sphaerulariaceæ, when attacked by Chytridiaceæ, "present appearances which have been a source of error in their interpretation". This rouses one's curiosity without gratifying it, but it is perhaps useful as an incentive to research. The following also seems rather too vague to be suitable for a manual for students: "A certain resemblance of this remarkable body to the Volvocineæ (fresh water) suggests inevitable speculations which may easily be made too much of".

In perusing the book one comes across occasional misprints, which will, no doubt, be corrected in a future edition. Thus, on page 190, the size of unusually large Diatoms is given as a third of a micro-millimetre for fresh water forms, and about three micro-millimetres for marine forms. Taking a micro-millimetre in the sense in which it is used by botanists and zoologists, this would make the length of these Diatoms about a hundredth part of the real value.

A book on Algae has long been a desideratum, and all students will feel indebted to the author for removing many of the difficulties which have hitherto hedged round the study of some of the most interesting groups of the Vegetable Kingdom.

## APPENDIX II.

### CHEMICAL LITERATURE FOR DECEMBER, 1895.

Vol. i. No. 1. *American Journal of Science*. (January, 1896.)

*Wells, H. L.*, and *Foote, H. W.*, Double Fluorides of Caesium and Zirconium (pp. 18-21).  
*Gooch, F. A.*, and *Peirce, A. W.*, Iodometric Determination of Selenious and Selenic Acids (pp. 31-35). *Browning, E. P.*, Interaction of Chromic and Arsenious Acids (pp. 35-38).

Vol. xvii. No. 12. *Journal of the American Chemical Society*. (Dec., 1895.)

*Wait, C. E.*, A Convenient Still for the Laboratory (pp. 917-920). *Trubek, M.*, On the Estimation of the Extraction in Sugar Houses (pp. 920-923). *De Chalmot, G.*, On Silicides of Iron (pp. 923-925). *Williams, C. B.*, Estimation of Phosphoric Acid in Soils by Double Precipitation with Molybdic Solution, and Titration of the Ammonium Phosphomolybdate with Standard Alkali (pp. 925-927). *Walker, P. H.*, On the Use of Organic Bases in the Preparation of Barium and Calcium Ferrocyanides (pp. 927-932). *Linebarger, C. E.*, On the Formation of Layers in Mixtures of Acetic Acid and Benzine (pp. 932-933). *Hyde, F. S.*, Scheme for the Identification of Acetanilide, Phenacetine, Quinine Sulphate, etc. (pp. 933-935). *Blasdale, W. C.*, On the Physical and Chemical Properties of Some California Oils (pp. 935-941). *Kilgore, B. W.*, The Determination of Phosphoric Acid by the Molybdate-Magnesia Method and by Volumetric Methods (pp. 941-943). *Auchy, G.*, The Volumetric Estimation of Manganese (pp. 943-947). *Venable, F. P.*, An Early Arrangement of the Elements (pp. 947-950). *Kilgore, B. W.*, On the Estimation of Phosphoric Acid by Titration of the Ammonium Phosphomolybdate Precipitate with Standard Alkali (pp. 950-969). *Dudley, W. L.*, The Relationship of the Heat of Vaporisation of Gases to their Density and also to their Boiling Point (pp. 969-986). *Gill, A. H.*, and *Hunt, S. P.*, The Determination of Methane and Hydrogen by Explosion (pp. 986-994).

Vol. xvii. No. 10. *American Chemical Journal*. (December, 1895.)

*Mabery, C. F.*, On the Composition of the Ohio and Canadian Sulphur Petroleums (pp. 713-748). *Stillman, J. M.*, and *Yoder, M. B.*, On the Combination of Anhydrous Ammonia and Aluminium Chloride (pp. 748-754). *Schlundt, H.*, and *Warder, R. B.*, The Chemical Kinetics of Oxidation. I. On the Speed of the Liberation of Iodine in Mixed Solutions of Potassium Chlorate, Potassium Iodide and Hydrochloric Acid (pp. 754-770). *McCay, W. Le Roy*, On the Existence of the Sulphonylantimonates (pp. 770-779). *Freer, P. C.*, Tetrinic Acid (pp. 779-796).

Vol. lxvii. No. 397. *Journal of the Chemical Society*. (December, 1895.)

*Henderson, G. G.*, and *Prentice, D.*, The Action of certain Acidic Oxides on Salts of Hydroxy Acids. II. (pp. 1030-1040). *Dixon, A. E.*, Acidylthiocarbimides (pp. 1040-1049). *Smithells, A.*, On Flame Temperatures and the Acetylene Theory of Luminous Hydrocarbon Flames (pp. 1049-1063). *Young, G.*, Synthesis of Diphenyloxytriazole (pp. 1063-1071). *Thomas, G. L.*, and *Young, S.*, The Vapour Pressures, Specific Volumes, and Critical Constants of Normal Hexane (pp. 1071-1084). *Perkin, A. G.*, Some Constituents of the Root of *Polygonum Cuspidatum* (pp. 1084-1090). *Chattaway, F. D.*, and *Ingle, H.*, A New Series of Hydrazines (pp. 1090-1095). *Divers, E.*, and *Haga, T.*, Sodium Nitrososulphate (pp. 1095-1098). *Divers, E.*, and *Haga, T.*, The Constitution of the Nitrososulphates (pp. 1098-1105). President's Address (pp. 1105-1172).

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*Perkin, W. H.*, Influence of Temperature on the Refractive Power and on the Refraction Equivalents of Acetylacetone and of Ortho- and Para-toluidine (pp. 1-7). *Meldola, R.*, and *Andrews, E. R.*, The Alkaline Reduction of Meta-nitraneline (pp. 7-17). *Dixon, A. E.*, The Chemistry of Dibromopropylthiocarbimide and the Action of Bromine and of Iodine

on Allylthiourea (pp. 17-36). *Forster, M. O.*, Studies of the Terpenes and Allied Compounds. New Derivatives from  $\alpha$ -Dibromocamphor (pp. 36-61). *Kipping, F. S.*,  $\omega$ -Bromocamphoric Acid (pp. 61-66). *Paterson, D.*, Efflorescence of Double Ferrous Aluminium Sulphate on Bricks exposed to Sulphur Dioxide (pp. 66-68). *Schunck, E.*, and *Marchlewski, L.*, Some Derivatives of Anthraquinone (pp. 68-74).

Vol. xiv. No. 12. *Journal of the Society of Chemical Industry.*  
(31st December, 1895.)

*Hargreaves, J.*, Alkali-Manufacture by the Hargreaves-Bird System of Electrolysis (pp. 1011-1017). *Rideal, S.*, and *Rosenblum, S.*, The Analysis of Chrome Iron Ore, Ferro-Chromium and Chrome Steel (pp. 1017-1019). *Bailey, G. H.*, The Volatilisation of Salts during Evaporation (pp. 1020-1021). *Pattinson, J.*, and *Pattinson, S. H.*, Note on the Estimation of Phosphorus in Iron and Iron Ores containing Titanium (p. 1022). *Hogg, T. W.*, A Note on Colorimetry (pp. 1022-1023). *Shaw, S.*, Deposits found in Old Workings at Delaval Benwell (Northumberland) and Tanfield Lea (Durham) Collieries (pp. 1023-1024). *Clowes, F.*, The Composition of the Limiting Explosive Mixtures of Combustible Gases with Air (pp. 1024-1025). *Procter, H. R.*, and *Towse, W.*, Note on the Saline Earth used in Curing Hides in India (pp. 1025-1026). *Perkin, A. G.*, Note on a Method of Subliming Alizarin (pp. 1026-1027). *Proude, J.*, and *Wood, W. H.*, On the Cause of the Change in Colour of Soaps containing Indigo Extract (p. 1027). *Proude, J.*, and *Wood, W. H.*, On the Solubility of Indigo in Oils (pp. 1027-1028). *Tervet, R.*, Destorative Distillation (pp. 1028-1030). *Schweitzer, H.*, and *Lungwitz, E.*, The Iodine Number of Fats and Oils (pp. 1030-1035).

Vol. xli. No. 248. *The Philosophical Magazine and Journal of Science.*  
(January, 1896.)

*Griffiths, E. H.*, and *Dorothy Marshall*, The Latent Heat of Evaporation of Benzene (pp. 1-38). *Dorothy Marshall*, and *Ramsay, W.*, A Method of Comparing Directly the Heats of Evaporation of Different Liquids at their Boiling Points (pp. 38-52). *Appleyard, R.*, A Direct-reading Platinum Thermometer (pp. 62-72).

Tome vii. *Annales de Chimie et de Physique.* (January, 1896.)

*Berthelot*, Recherches sur l'argon et sur les combinaisons (pp. 5-27). *Berthelot*, Sur la combinaison de l'azote libre avec les éléments du sulfure de carbone (pp. 27-29). *Berthelot et Rivals*, Nouvelles recherches sur les relations thermochimiques entre les aldéhydes, les alcools et les acides (pp. 29-47). *Berthelot et Rivals*, Sur les lactones ou olides campholéniques (pp. 47-50). *Berthelot*, Sur les chaleurs de dissolution et de neutralisation des acides campholéniques (pp. 50-51). *Berthelot*, Relations thermochimiques entre les états isomériques du glucose ordinaire (pp. 51-58). *Carvallo, E.*, Absorption de la lumière par les cristaux (pp. 58-94). *Meslans, M.*, Sur les vitesses d'étherification de l'acide fluorhydrique (pp. 94-112). *Moisan, H.*, Analyse de quelques échantillons de chandôo et étude chimique de la fumée d'opium (pp. 112-125). *Wunsch, A.*, Sur la benzoïquinine (pp. 125-144).

Tomes xiii.-xiv. No. 24. *Bulletin de la Société Chimique de Paris.*  
(20th December, 1895.)

*Varet, R.*, Recherches sur les combinaisons du cyanure de mercure avec les sels halogénés (pp. 1096-1092). *Brizard, L.*, Sur quelques sels d'Argent du ruthénium nitrosé (pp. 1092-1093). *Vaillant, V.*, Action du chlorure de carbonyle sur la dithiocétylecétone (pp. 1094-1095). *Bertrand, G.*, Sur la recherche et la présence de la laccase dans les végétaux (pp. 1095-1098). *Manceau, E.*, Sur le dosage du tannin dans les vins (pp. 1098-1101). *Winter, J.*, Température de congélation des liquides de l'organisme. Application à l'analyse du lait (pp. 1101-1107).

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